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DEVELOPMENT OF SPECIAL PROVISIONS FOR THE ACCEPTANCE OF LEAN CONCRETE BASE, CONCRETE BASE AND CONCRETE PAVEMENT

MATERIALS INFORMATION
ENGINEERING MATERIALS OFFICE

DEVELOPMENT OF SPECIAL PROVISIONS FOR THE ACCEPTANCE OF LEAN CONCRETE BASE, CONCRETE BASE AND CONCRETE PAVEMENT

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SUMMARY

The Ministry is in a process of changing its construction specifications from the "materials and methods" to the "performance (end result)" type. This report describes the development of the end result specifications for lean concrete base, concrete base and concrete pavement.

The report determines the properties governing the performance of a concrete base slab and pavement, evaluates the variability of these properties on a number of contracts in South-Western Ontario and recommends realistic and attainable requirements for these properties (slump, air content, core compressive strength, slab thickness and, only for concrete pavement, profile index).

The recommended sampling plan, requirements for each of the properties and price adjustments are shown in Appendix B.

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INTRODUCTION

The Ministry is in a process of changing its construction specifications from the "materials and methods" to the "performance (end result)" type.

The existing materials and methods type specifications tell the contractor HOW he must produce a concrete base, pavement or structure. The Ministry designs the concrete mix, does the process control testing and makes the contractor responsible for the attainment of the specified properties. Obviously, there are some conflicts here.

The performance (end result) specifications tell the contractor WHAT the end product must be, not how he must produce it. The process control testing is the responsibility of the contractor. Such specifications, to be effective, must:

i) be based on realistic, attainable requirements that take into account the inherent variability in materials and construction processes

ii) clearly spell out in advance the acceptance procedures including price adjustments where applicable.

This report describes the development of the end result specifications for lean concrete base, concrete base and concrete pavement. The work started in the summer of 1981 and was completed in the spring of 1984.

OBJECTIVES

The objectives of this project were to:

i) establish the properties that will govern the acceptance/rejection of lean concrete base, concrete base and concrete pavement

ii) determine the variability of each of the properties on a number of concrete base and pavement contracts

iii) establish realistic requirements for each of the specified properties

iv) draft an end result specification for lean concrete base, concrete base and concrete pavement to be recommended for approval by the Quality Assurance Systems Committee.

PROPERTIES GOVERNING BASE/PAVEMENT PERFORMANCE

Lean concrete base, concrete base or concrete pavement is designed and constructed to adequately serve the travelling public for a long time. The designer assumes that the durability and the strength of the concrete, and the thickness of the base or pavement and the riding quality of the pavement will be as specified. Form 350 specifies the riding quality, the tolerances for the thickness and by reference to Form 1350, the quality of the concrete. The quality of concrete ingredients is specified by other Ministry specifications and it is not a subject of this report.

There are also other factors that govern the performance of the base or pavement, such as curing procedure, cutting of joints, sealing of joints. These are covered by Form 350; no tests are carried out but the procedures used by the contractor are observed by the Ministry staff to ensure adherence to the specified methods.

Concrete Properties

Three concrete properties are tested: slump, air content and strength. The first property is to ensure that the concrete has the specified consistency for its placing, consolidation and finishing of the surface; the second to ensure that it has the specified air entrainment to resist the action of freezing and thawing in the presence of deicing salt; and the third to have adequate resistance to abrasion (pavement) and the load. In addition, the strength is a measure of the overall quality of concrete and thus it is the most important property.

MTC Form 350, itself or by reference to Form 1350, gives guidelines for slump and its tolerance, specifies air content and its tolerance, and states when the concrete complies with the requirements for strength. Compliance with the requirements for compressive strength, as well as flexural strength (for concrete base and concrete pavement) is required. The frequency of each of the tests is specified by Provincial Highways Directive B-42.

Since each of the three properties is important, they are tested and govern the acceptance or rejection of the concrete. It is obvious that slump and air content must be tested immediately after the concrete is deposited on the grade. The samples must be obtained from the grade so that they represent the concrete constituting the base or pavement as close as possible (the end result). It has been the practice to cast strength specimens from the samples. However, there is a possibility that the standard strength test may be substituted with a core strength test without any significant adverse effects on the precision of the tests. Since the cores are obtained from the finished product, the test would assess the final product (the end result).

Thickness of Base/Pavement

The load carrying capacity of a lean concrete base, concrete base or pavement depends largely on the thickness of the slab. Therefore, it is necessary to ensure that the thickness of the slab is as designed and within the tolerance specified in Form 350.

Riding Quality

The travelling public wants pavements with an adequately comfortable (smooth) ride at the posted speeds. The current MTC Form 350 specifies the smoothness of concrete pavement to be such that "when tested with a 3 m long straight edge placed anywhere in any direction on the surface, except across the crown or drainage gutters, there shall not be a gap greater than 3 mm between the bottom of the straight edge and the surface of the pavement". Since this method is impractical for many reasons (time consuming, straight edge too short, not mechanized, etc) the Profile Index is now used as a measure of surface smoothness by some highway authorities[1,2,3]. It is a sum of the vertical deviations outside a 0.2 inch blanking band, as indicated on the Profile Trace produced by the moving profilograph. It is expressed in inches per mile. The trace also shows bumps. They are determined by locating on the Profile Trace vertical deviations outside a 0.5 inch maximum for a 25 foot span. The Profile Index requirement is favoured over the current requirement of Form 350 for smoothness. The future MTC specification for concrete pavement should specify a Profile Index.

VARIABILITY OF THE SPECIFIED PROPERTIES

End result specifications must be based on realistic, attainable requirements. Therefore, slump, air content, compressive strength and slab thickness were measured on each lean concrete base, concrete base and concrete pavement contract in 1981 and 1982 to obtain as much data on the variability of the properties as possible. The tests were carried out by experienced technicians on samples of the concrete taken from the grade. In addition, the Profile Index was determined on the only concrete pavement contract in 1982. The pavement structure on each contract is shown in Fig.1. The lean concrete base, the base and the pavement were placed by slipforming with the exception of the lean concrete base and the base on contract 81-05, E.C. Row Expressway, Windsor. Side forms were employed on this contract. The concretes were batched and mixed by central mixing plants on contracts 80-73, 81-54, 81-102 and 82-67. Ready mixed concrete was used on contract 81-05. Both ready mixed concrete and concrete mixed by a central mixing plant were used at the same time on contract 82-01.

Slump

MTC Form 1350 indicates that slumps of 60 mm and 30 mm are reasonable for concrete pavement placed by the conventional forming and by slipforming, respectively. It also states that the tolerance in slump of concrete placed in any one structural element "shall be within ±10 mm when the specified slump is less than 80 mm". Form 350 specifies that slump for lean concrete base shall be within 30-80 mm.

Table A shows the test results obtained on each of the six contracts and Fig.2 and 3 show the frequency histograms.

Lean Concrete Base. It is evident from Table A and Fig.2 that the lean concretes did not comply with the requirements for slump on any of the contracts. The best control was achieved on contract 81-102 and 82-67 where more than 90% of the test results were within the specified limits (30-80 mm). The lowest standard deviation was 11.1 (contract 81-102) and the highest 28.6 mm (contract 80-73). When the highest standard deviation (28.6 mm) is ignored, the average standard deviation of the five contracts amounts to 14.96 mm. At least one of the five standard deviations (contract 82-01, 21.2 mm) also appears to be too high indicating insufficient effort to maintain the slump within the specified limit. Nevertheless, the current limits do not seem to be realistic and a change to the requirement that all test results be within 55 ± 45 mm is justified for lean concrete base. When this requirement is applied to the six contracts, 88.2% of the test results on contract 80-73 and at least 96.0 on any of the other

contracts will be within the limits (55 ± 45 mm). This means that some loads of concrete would have been rejected, if these limits (55 ± 45 mm) had governed the acceptance/rejection of the concrete on these contracts. However, it is obvious that some loads of the concrete should have been rejected (Fig.2, range of test results).

Concrete Base and Pavement. The test results show that the slump and tolerance suggested by Form 1350 for side forming (contract 81-05) as well as for slipforming are grossly unrealistic. The mean slump for the concrete placed by slipforming varied from 47.4 to 67.5 mm while the guideline was 30 mm. The mean slump for the concrete placed by side forming (contract 81-05) was 74.1 mm and the suggested slump is 60 mm. The tolerance of ± 10 mm specified by Form 1350 is much too low to envelop all test results. The average standard deviation for the six contracts is 16.3 mm, thus, the same tolerance as for the lean concrete (± 45 mm) would be justified and realistic for the base and pavement concrete. A mean slump of 55 mm would also be realistic for each of the two methods of placing the concrete. When the limits of 55 ± 45 mm are applied to each of the six contracts, the lowest compliance will be on contract 81-54 (89.9%) followed by contract 80-73 (93.9%). Fig.3 (range of test results) shows that some rejection would have been justified.

Air Content

The current MTC Form 350 specifies an air content of 8.0 ± 2.0% for lean concrete base, and the current MTC Form 1350 specifies an air content of 6.0 ± 1.5% for concrete base and concrete pavement where the nominal maximum size of the coarse aggregate is 19.0 mm. The test results obtained on the six contracts are shown in Table B and Fig.4 and 5. It is important to note here that the test results on all the contracts were obtained on samples of concrete deposited on the grade. However, in the case of contract 80-73 and 81-54 the concrete was also tested for air content at the exit from the central mixing plant yard and accepted at that point.

Lean Concrete Base. When the means on contract 80-73 and 81-54 are ignored, the mean on each of the remaining four contracts was between 7.17 to 8.50%, close to the specified mean of 8.0%. The standard deviation on the six contracts varied from 0.78 to 1.01%, the average standard deviation was 0.84%. Each of the four contracts complied with the current specification requirement for air content in at least 92.6% and maximum 98.6%. If the current requirement had been strictly enforced, some loads of concrete on each of the contracts would have been rejected and this rejection would not be justified from the point of view of the

quality of the concrete base. A tolerance of approximately three average standard deviations (± 2.5%) and a mean of 8.5% would be considered as a realistic requirement for the lean concrete base.

Concrete Base and Pavement. There were some problems with the control of air content on contract 82-01 and this increased the standard deviation on this contract to 1.00%. When this contract is ignored, the standard deviation on each of the other five contracts was within 0.64 to 0.84%, the average of 0.71%. This indicates that the present tolerance of ± 1.5% is too low and that a tolerance of ± 2.0% would be realistic. Such an increase in tolerance would also necessitate an increase in the air content to 6.5% to ensure adequate durability. When these limits (6.0 ± 2.0%) are applied to the four contracts, the percent compliance will change from minimum 86.6% and maximum 96.3% to minimum 95.4% (contract 82-01) and maximum 99.4% (contract 81-05).

Compressive Strength

The current MTC Form 350 specifies that the compressive strength of lean concrete shall be at least 10.0 MPa at 28 d as tested using the standard cylinder test method. The concrete for the concrete base and pavement is covered by Form 1350 which, in addition to the requirements for compressive strength (see Table C), states that the flexural strength shall be at least 3.8 MPa at 10 d. The flexural strength was not tested for this project.

In addition to the compressive strength determined on the cast standard cylinders, compressive strength was also determined on cores obtained from the placed and cured base and pavement structures. The timing for the coring, curing and testing as well as the size of the cores are described in Appendix A, Specification for Obtaining and Testing of Cores from Concrete Pavement for Length and Compressive Strength. The timing and procedure were the same for the other contracts where the age of the concrete base governed the time of coring.

Table C and Fig.6 and 7 show the test results of the standard 28 d compressive strength tests, and Table D and Fig. 8 and 9 show the test results of the core compressive strength tests.

It is evident from Table C that only the lean concrete base on contract 82-01 did not comply fully (100%) with the requirements for the standard 28 d compressive strength. The compliance was 97.4%. The concrete bases and the pavement complied fully with the requirements. It should be noted here that the lean concrete on all contracts except 82-01 had a cement content of 200kg/m^3; the cement

content on contract 82-01 was 175 kg/m^3. A minimum of 175 kg/m^3 is specified by the current MTC Form 350. It is interesting to note that the mean strength of the lean concretes of the five contracts varied only from 18.3 to 20.9 MPa (average 19.1 MPa) and the mean strength of the base and pavement concrete from 32.7 to 37.6 MPa (average 34.9 MPa).

The standard deviations of the lean concrete varied from 1.69 to 2.87 MPa (average 2.32 MPa), and of the bases and pavement from 2.43 to 4.10 MPa (average 3.21 MPa).

Table D and Fig.9 show that the variability of the core compressive strength is greater than that of the standard 28 d compressive strength. The standard deviation of the lean concrete varied from 2.31 to 4.23 MPa (average 3.50 MPa) and of the bases and pavement from 3.78 to 5.11 MPa (average 4.12 MPa). It is also noted that the ratio of the core to 28 d cylinder strength for the lean concretes was from 1.03 to 1.55 (average 1.24), and for the bases and pavement 0.91 to 1.14 (average of 1.04). If the requirements for the standard 28 d compressive strength are replaced with the requirements for the core compressive strength, it appears that it would be reasonable and realistic to require lean concrete to have a minimum core compressive strength of 10.0 MPa and concrete base or pavement a minimum core compressive strength of 25.0 MPa. The lean concrete would have to have a mean core strength of 10.0 + 2 x 3.50 = 17.0 MPa and the base or pavement concrete would have to have a mean core strength of 25.0 + 2 x 4.1 = 33.2 MPa for 97.7% compliance with the above requirements. The lowest mean lean concrete core strength was 18.8 MPa (contract 82-01) and the lowest mean base or pavement core strength was 32.5 MPa (contract 81-05). With a small improvement in the quality control, the requirements should be easily attainable.

Slab Thickness

The thicknesses of lean concrete base, concrete base and concrete pavement slabs specified for the contracts are shown in Table E together with the test results of the core length test. The tolerances shown are those specified by the current MTC Form 350. Figs. 10 to 12 show the frequency histograms for the core length test results.

Lean Concrete Base. The standard deviation of the core length test results varied on the six contracts from 14.3 to 22.1 mm (average 16.9 mm), with the one for contract 81-05 being substantially higher (22.1 mm) than the highest of the other 5 contracts (17.2). When this exceptionally high standard deviation is

ignored, the remaining five, varying from 14.3 to 17.2 mm, produce an average of 15.9 mm. Thus, a standard deviation of approximately 15.0 mm would be attainable and realistic provided that in the future contracts the smoothness of the sub-base and the thickness of the lean concrete base can be somewhat better controlled than on these six contracts without any significant increase in the cost of construction.

The tolerance specified by the current MTC Form 350 (± 20 mm) is unrealistic (too small). An increase from ± 20 mm to ± 30 mm (2 standard deviations, 95% compliance) appears to be justified.

Table E and Fig. 10 show that, for three of the contracts the mean core length is significantly higher and for one contract significantly lower, than the specified. This indicates that trial runs are needed to set the forms or guides properly to produce a mean slab thickness closer to the specified.

Concrete Base. The mean thickness of the slab on each of the six contracts is close to that specified. However, the variability of the slab thickness is considerably greater than allowed by the current MTC Form 350 (± 16 mm). The standard deviation varied from 9.3 to 15.1 mm with an average of 11.6 mm. An increase in the allowable tolerance from ± 16 mm to at least ± 25 mm would be justified by the data.

Concrete Pavement. The data is only from one contract and the pavements were placed by the same contractor. The means of the core lengths are close to the specified slab thicknesses. The variability of the core length is much greater than allowed by the current MTC Form 350 (± 12mm). The standard deviation varied from 9.1 to 16.9 mm with the average being 13.0 mm. If the tolerance (± 12 mm) is increased to ± 30 mm, the data indicates that the contractor would have to improve his placing operations to avoid a possibility of some rejections.

Riding Quality

Table F shows the Profile Index for each 250 ft, 1000 ft, 4000 ft and each day's paving. The digits in brackets in the "Profile Count" column show the number of bumps in each 250 ft section of each wheelpath. Since the profilograph produced data in imperial units so the data in Table F are in these units. The profile indices are averages of the profile indices for the four wheelpaths (two lanes placed with one pass of the paving train) for the section from stations 01+50 to 230+50SG, 00+00 to 100+00NG and for the two wheelpaths (one lane placed with one pass of the paving train) from station 100+00 to 278+00 and 278+00 to 100+0NG. The profilograph traversed the pavement in the direction of the paving.

Table G summarizes the data shown in Table F. As was expected the profile index of the 1000 ft sections varied significantly more than that of the 4000 ft sections or one day's paving sections. It is also evident that the number of lanes placed by one pass of the paving train had a very significant effect on the profile index. The ratio of the mean Profile Index for the 4000 ft sections for the two lane and the one lane construction is approximately 2.0. It should be noted that the two lane construction pavement was placed on a subgrade while the one lane construction pavement was placed on a lean concrete base (Fig.1).

In the two lane construction, wheelpath #1 was the closest to the paving train guide and this wheelpath had the lowest Profile Index followed by wheelpath #2, #3 and #4 (Table F). The proportions of average profile index of wheelpath #1:2:3:4 were approximately 1:2:3:4. There were also fewer bumps in wheelpath #1, followed by wheelpath #2, #3 and #4. There were approximately 9 times more bumps in wheelpath #4 than in #1.

No such large differences were observed between the wheelpaths in the one lane construction. In one direction, the profile index (4000 ft sections) of wheelpath #1 (average 7.0 in/mile) was somewhat higher than that of wheelpath #2 (average 6.0 in/mile) while in the other direction (the guide closest to wheelpath #4) the profile index of wheelpath #3 (2.0 in/mile) was significantly lower than that of wheelpath #4 (4.0 in/mile). While in the one lane construction the profile index of the wheelpath closest to the paving machine guide is larger than that of the other wheelpath, in the two lane construction the opposite is true.

There is a probability that not more than 5% of the 4000 ft sections would have a profile index higher than 9.75+1.645x4.13=16.5 in/mile for the two lane construction and 4.93+1.645x2.15=8.5 in/mile for the one lane construction. A medium size car was driven on the pavement a number of times and the riding quality was assessed as being fair, mainly because of the bumps in some areas, especially at the construction joints. Corrections (grinding of the bumps) should be carried out in those areas. There is no doubt that such corrections will improve the profile index and, in addition, there is a need for a better control of the finishing operations. It appears that a profile index of 12 in/mile (4000 ft sections) would be a reasonable and realistic requirement for the final riding quality. In metric, it would be rounded slightly upward to 200 mm/km (12.7 in/mile).

REALISTIC, ATTAINABLE REQUIREMENTS

The specified properties can be divided into two distinct groups. The properties determined on samples of fresh concrete - slump, air content and temperature - constitute one group, and the properties determined on hardened concrete - compressive strength, slab thickness and riding quality - constitute the other group. Loads of concrete that do not comply with the requirements for the fresh concrete properties may be rejected immediately after completion of the tests while decision as to the acceptance of the concrete (pavement) on the basis of the other properties is made after the concrete pavement has been placed and cured.

Slump, Air Content, Temperature

Slump is mainly governed by the water-cement ratio and this governs the overall quality of the concrete. Therefore it is in the interest of the Ministry not to allow the use of high slump concrete. Too low a slump may have adverse effects on the compactability and finishibility of the concrete. For these reasons, and also for uniformity of the product, the upper as well as the lower limit should be specified. Some highway agencies (4,5,7) specify the upper limit only, others (1,2,6,8,9,10,11) both the lower and the upper. The 1981 and 1982 tests point out that the following limits for slump are attainable and realistic for side form as well as slipform construction:

lean concrete base	55±45 mm
concrete base and pavement	55±45 mm

In no case should loads of concrete with a slump outside these limits be accepted.

The field tests showed that the air content tolerances specified at present are unrealistic and that they should be increased to the following values:

lean concrete base	± 2.5%
concrete base and pavement	± 2.0%

This increase in the tolerances will necessitate an increase of 0.5% in the specified air content to ensure adequate durability. These tolerances would be similar to those specified by some other highway agencies (6,7,11). No load of concrete whose air content is outside these limits should be accepted.

Temperature is adequately specified by the current Form 1350.

Compressive Strength, Slab Thickness, Profile Index

The current specifications require that compressive strength be determined using the standard method (28 d cylinders). This method does not determine the strength of the concrete in the base or pavement but only the potential strength - the strength developed by the concrete under the specified conditions (Table C). The testing of cores obtained from a base or pavement slab determines the strength of the concrete in the slab and, thus, it provides much better information on the quality of the slab. For this reason, acceptance of the slab should be based on the strength of cores, not cast cylinders. It was shown in the preceding chapter that the following core strength requirements would be attainable and realistic:

lean concrete base	min. 10.0 MPa
concrete base and pavement	min. 25.0 MPa

Attainable and realistic slab thickness (core length) tolerances for Ontario conditions appear to be as follows:

lean concrete base	± 30 mm
concrete base and pavement	± 30 mm

Such large departures from the design thickness may have detrimental effect on the load carrying capacity of the pavement and should not be allowed without a significant reduction in the payment for the pavement. This will necessitate a substantial improvement in the control of the slab thickness by the contractor if the average thickness is to be closer to the design thickness. State highway transportation departments such as Louisiana[12] and California[1] require removal of concrete pavement area deficient in thickness by more than 25 mm (1.0 in.) and 15 mm (0.6 in.), respectively.

A profile index of 200mm/km appears to be a realistic requirement and should be attainable by an experienced contractor with no difficulty. All bumps and sections with a profile index of over 600 mm/km must be corrected by grinding and the final profile index must be determined after the corrections. This requirement would be less severe than that of California's[1] which requires "pavement on tangent alignment and pavement on horizontal curves having a centerline radius of curve 2000 ft or more shall have a Profile Index of 7 inches per mile (110 mm/cm) or less" and New York's which allows a Profile Index of 189 mm/km (12 in/mile) with no reduction in payment.

ACCEPTANCE PLAN

The acceptance of concrete and the finished base or pavement will be based on the acceptance of fresh concrete on the basis of its slump, air content and temperature requirements and the hardened concrete - finished pavement on the basis of core compressive strength, thickness of the slab and, in the case of pavement, the Profile Index (riding quality).

Fresh Concrete

It is imperative that all tests are carried out on samples of concrete deposited in front of the paver on the grade so that the samples represent the concrete in the slab as close as possible. Sampling at the plant is not allowed because the properties of concrete change between the time it leaves the plant and the time it is deposited on the grade. The tests on contract 80-73 and 81-54 indicated a difference of 2 percentage points in the air content.

The frequency of sampling as specified by MTC Directive B-42, Provincial Highways is satisfactory. After satisfactory control of slump, air content and temperature has been achieved, the sampling must be on a stratified, randomized basis. Since the tolerances are increased, all loads of concrete outside the limits for each of the properties must be rejected.

Hardened Concrete

The Quality Assurance Systems Committee, Concrete Subcommittee has agreed that:

i) the base/pavement be accepted on a lot basis and that the lot be approximately 4000 m^2

ii) the lot be divided into 4 sublots of equal size

iii) the acceptance criteria for core compressive strength be based on the mean of the 4 test results. The lot be rejected when the mean strength is less than 6.0 MPa and 17.5 MPa for lean concrete base and concrete base or pavement, respectively. The maximum reduction in the payment to be not higher than 10% of the bid price

iv) the acceptance criteria for slab thickness be based on the mean of the 4 test results and the lot be rejected when the deficiency in the thickness is over 30.0 mm. The maximum reduction in the pavement to be 25%

v) maximum reduction in the payment for the profile index be 10% of the bid price

vi) the reduction in the payment for multiple deficiencies be calculated by adding the percentage reduction for each deficiency.

Compressive Strength. The size of cores, the age of the slab at the time of coring and the curing and testing of cores specified for the simulation projects (Appendix A) were found to serve the purpose well and they should be suitable for the Special Provision. The longitudinal and lateral location of the core in each sublot must be selected using a table of random numbers. To avoid boundary conditions, no core should be located less than 250 mm from an edge of the slab or from a joint.

The mean strength should be calculated as follows:

$X - X_1 + X_2 + X_3 + X_4$ for n=4

where X_1, X_2, X_3, X_4, is the individual strength for sublot 1, 2, 3 and 4, respectively.

X is the mean strength rounded off to the nearest 0.1 MPa.

The price adjustment can be based on the mean strength in accordance with the following table.

Adjustment of Contract Price				
Mean Compressive Strengths, MPa				Percent of Contract Price to be paid
Lean Concrete Base		Concrete Base or Pavement		
n = 4	n = 8	n = 4	n = 8	
⩾ 10.0	⩾ 11.6	⩾ 25.0	⩾ 26.8	100
9.9 - 9.0	11.5 - 10.6	24.9 - 23.5	26.7 - 25.3	99
8.9 - 8.0	10.5 - 9.6	23.4 - 22.0	25.2 - 23.8	97
7.9 - 7.0	9.5 - 8.6	21.9 - 20.0	23.7 - 21.8	94
6.9 - 6.0	8.5 - 7.6	19.9 - 17.5	21.7 - 19.3	90
< 6.0	< 7.6	< 17.5	< 19.3	Remove and replace slab

It is evident from Fig.8 that there were no lean concrete base core compressive strength test results below 10.0 MPa from any of the six contracts. There were some concrete base core compressive strength test results (Fig.9) below 25.0 MPa from contracts 80-73, 81-05 and 81-102. However, as Table H shows, there were no averages with values below 25.0 MPa thus there would be no price adjustments for any of the contracts.

There is no doubt that some low strength test results will be questioned by the contractor and, where appropriate, this can be resolved by taking additional cores from the lot. In such cases, 4 additional cores should be taken from the lot, one from each sublot. The location of the core in each sublot must be determined using a table of random numbers. All 8 cores should be used to calculate the mean strength. However, since 8 cores are now used to calculate the mean, and the variation in the means of n=8 is smaller than in the means of n=4, the strength in the above "Adjustment of Contract Price" table are increased to retain the same "Percent of Contract Price to be Paid" values for n=4 and n=8. The strength for n=8 were calculated assuming that the standard deviation of the population of the individual strength test results is 3 MPa for lean concrete base and 4.1 MPa for concrete base/pavement. These values are averages for the standard deviations in Table D. The additional 4 cores would be taken at a later age thus their strength would be higher than that of the first four. However, this effect is ignored.

Slab Thickness. The slab thickness in each lot can be evaluated for acceptance and payment on the basis of the deficiency in the average core length as follows:

Deficiency = $\bar{X}$ - Specified thickness

Average length $\bar{X} = \dfrac{x_1 + x_2 + x_3 + x_4}{n}$

where $\bar{X}$ is the average core length for the lot, rounded off to the nearest 0.1.

and x_1, ..., x_4 are the core lengths of the sublots

Each lot would consist of 4 sublots (n=4).

If any of the individual core lengths is more than 5 mm above the specified slab thickness, its length should be considered to be equal to the specified thickness plus 5 mm for the purpose of the calculation of X. This will give the contractor some credit for thicker than specified slab but it will also encourage him to place slabs with the average thickness closer to the specified and to reduce the variability.

The price adjustment can then be as follows:

Adjustment of Contract Price	
Deficiency in the Average Length of 4 Cores (lot), mm	Percent of Contract Unit Price to be Paid
0 - 3.0	100
3.1 - 6.0	99
6.1 - 9.0	97
9.1 - 13.5	94
13.6 - 18.0	89
18.1 - 22.5	83
22.6 - 30.0	75
30.1 or more	Remove and replace

Since this test is non-destructive, the length can be checked and re-checked when any of the cores are low in length thus no additional coring would be necessary for this purpose. However, if any of the individual core lengths is deficient in length by more than 30.0 mm, the area represented by the core should be cored to establish the extent of the area deficient in thickness. The additional cores should be taken at 3 m intervals along the longitudinal axis of the lane. The slab with a thickness deficiency greater than 30.0 mm should be removed and replaced at the contractor's expense. The area to be removed and replaced should be bounded by the nearest contraction joint and the nearest longitudinal joint or pavement edge outside the area so that there would be no additional joints where the joint spacing is less than 6.0 m. In cases where the joint spacing is more than 6.0 m, the part of the slab to be removed and replaced will be marked by the Ministry and construction joints will be allowed.

There will be situations where the lean concrete base is deficient in the thickness but the concrete base or pavement above it is thicker than specified. In such situations, the penalty may be reduced or removal and replacement of the slabs may be avoided if the excess thickness is credited to the lean concrete base. A good example is lot 1, Contract 81-05, (see Table I for lean concrete base and Table J for concrete base) where the payment for the lean concrete base is 83% and for the concrete base 99%. The calculation for this lot would be as follows:

Sublot Number	Lean Concrete Base Core Length, mm	Concrete Base Core Length, mm	Adjusted Lean Concrete Base Core Length, mm
1	117.5	208.0 (232.5)	142.0 (117.5+24.5)
2	147.5	197.5	147.5
3	125.0	190.0	125.0
4	135.0	197.5	135.0
$\bar{X}$	131.2	198.3	137.4
Deficiency, mm	-20.7	- 4.7	-14.6
Payment, %	83	99	89

The actual length of the concrete base core from sublot 1 was 232.5 mm and the maximum length allowed was 208.0 mm (specified length + 5.0 mm) thus the excess length of 24.5 mm was credited to the length of the lean concrete base core (117.5 + 24.5 = 142.0 mm). This changed the payment for the lean concrete base from 83 to 89% without changing the payment for the concrete base.

The lowest payment for the lean concrete base would be 75% and it would occur on Contract 81-05, Lot 2 and Lot 5 where the deficiency was 25.1 mm and 22.6 mm, respectively. When the correction is applied to these two lots, the payment increases from 75 to 83% for each of the two lots.

The application of this correction would increase the reduced payments in Table I in most cases.

Table J shows the payment adjustments for the 5 concrete base contracts. It is evident that there are many lots where price adjustment would be made. The payment would be 83% for 0.8% of the total number of the lots, 89% for 4.3%, 94% for 7.7%, 97% for 12.0% and 99% for 12.0%. Full payment would be made for 74 of the total of 117 lots (63.2%).

Table K shows that the price adjustment would be made in 11 out of 30 lots of concrete pavement. The lowest payment would be 89% and it would apply to lots 6, 7 and 8 (specified thickness 203 mm), 94% would be paid for two lots, 97% for two lots and 99% for 4 lots.

No removal and replacement of lean concrete base, concrete base or concrete pavement would be required on any of the six contracts.

In future operations, the contractors would have to improve their process control to avoid reduced payments.

Profile Index. The profilograph and the procedure for the determination of Profile Index and bumps would be the same as that employed by New York(2). The requirements would be that all bumps be corrected by grinding and that a final profile index (after corrections by grinding) of 200 mm/km (12.7 in./mile) or lower would call for a full payment of the bid price. When the profile index in any lot is greater than 200 mm/km, the lot (pavement) would be paid for in accordance with the following schedule:

Profile index, mm/km	Percent of the Contract Unit Price to be Paid
⩽ 200	100
201 - 275	99
276 - 350	97
351 - 450	94
451 - 600	90

If the profile index in any lot after correcting the bumps, is not less than 601 mm/km, the contractor would be required to correct the pavement by grinding to reduce the profile index. The initial and the final profile index would be determined for each lot (4000 m^2).

Multiple deficiencies

When a slab fails to qualify for the full bid price payment due to a single deficiency (compressive strength or slab thickness or profile index), there is no problem with the establishment of the percent payment. Simply, the payment is in accordance with the price adjustment schedule for the property. However, if a slab fails to qualify for the full bid price payment due to two or three deficiencies, a formula must be developed for such payments.

If the formula for the final payment is

$P = A + B + C - 200$ for concrete pavement

$P = A + B - 100$ for lean concrete base and concrete base

where P = Final payment, % of bid price

A = Percent payment dictated by the deficiency in core compressive strength

B = Percent payment dictated by the slab thickness deficiency

C = Percent payment dictated by the profile index

the lowest payment for concrete pavement would be

P = 90 + 75 + 90 - 200 = 55% and for lean concrete base or concrete base P = 90 + 75 - 100 = 65% of the bid price. The above are the extreme cases. It is a very small probability that the three properties are such that the payment would be adjusted to this lowest payment.

In the case of the six contracts, the lowest payment for lean concrete base would be 83%, (after corrections), for concrete base 83%, and for concrete pavement 89%. All the above deductions are due to the deficiencies in the thickness. Only in one case was the profile index above 200 mm/km (16.4 in./mile = 258.7 mm/km, Station 84+00 to 124+50) but the grinding of the bumps would reduce the index to below 200 mm/km. It does not appear that the formula will impose unjust payment reduction on the contractor.

CONCLUSIONS AND RECOMMENDATIONS

The 1981 and 1982 field tests on lean base, base and pavement concretes provided us with the data on the variability of slump, air content, and core compressive strength as well as thickness of the slabs and surface roughness of the pavement. Knowledge of these variabilities allowed us to develop realistic and attainable end result specification requirements.

Special Provisions for the acceptance of lean concrete base, concrete base and concrete pavement have been drafted. They are enclosed as Appendix B. Method of testing the concrete for the compressive strength and slab thickness and the pavement for the profile index is enclosed as Appendix C.

It is recommended that the Special Provisions and the Method of Test be tried on at least one contract to allow modifications as necessary before wide spread implementation.

REFERENCES

1. "Standard Specifications, Section 40-Portland Cement Concrete Pavement", State of California Department of Transportation, January 1978.

2. "Standard Specifications, Section 500-Rigid Pavements", "15502.0401- Cement Concrete Pavement, Reinforced, Class C, Profilographed" and "15502.0601- Cement Concrete Pavement, Unreinforced, Class C, Profilographed", New York State Department of Transportation.

3. "Reinforced or Plain Cement Concrete Pavements, Supplementing the Specifications Form 408 dated 1976". Attachment to C-408/76-102, Section 501, July 17, 1979, Commonwealth of Pennsylvania, Department of Transportation.

4. "Section 430-Portland Cement Concrete Pavement", State of Georgia, Department of Transportation.

5. "Special Provisions F 028-1-505", Arizona Department of Transportation, 05-30-80.

6. "Form 408 Specifications", Commonwealth of Pennsylvania, Department of Transportation, 1976.

7. "Standard Specifications, Roads and Bridges", West Virginia Department of Highways, Adopted 1982.

8. "Standard Specifications", Indiana State Highway, 1974.

9. "Standard Specifications for Road and Bridge Construction", Illinois Department of Transportation, Adopted July 1, 1976.

10. "Standard Specifications for Highway Construction", Michigan Department of State Highways, Adopted July 1, 1970.

11. "Section 601-Portland Cement Concrete Pavement" and "Section 901-Portland Cement Concrete", Louisiana Department of Transportation and Development.

12. "Application of Quality Control Specifications for Portland Cement Concrete Pavement and Structures", Louisiana Department of Transportation and Development, July 1978.

13. "Determination of Statistical Parameters, Phase II, Concrete Pavement and Structures", Research Project No. 73-3, July 1975, Commonwealth of Pennsylvania, Department of Transportation.

14. "Practical Application of Statistical Quality Control in Highway Construction", Prepared by The Sigma Partnership under Contract No. DOT-FH-11-9435 for U.S. Department of Transportation, Federal Highway Administration.

TABLE A: Results of the Slump Tests

	Construction Year					
	1981		1982			
	Contract Number					
	80-73	81-54	81-05	81-102	82-01	82-67
	Lean Concrete Base					
Number of tests, n	57	109	306	150	108	694
Mean, $\bar{x}$, mm	58.6	47.8	76.7	50.7	62.9	46.5
Std. dev., S_x, mm	28.6	18.1	13.2	11.1	21.2	11.2
Coeff.of variation, V, %	48.8	37.9	17.2	21.9	33.7	24.1
Requirement, mm	30-80					
% within limit	61.4	80.0	60.0	96.5	72.9	92.8
	Concrete Base					
No. of tests, n	120	114	339	511	-	662
Mean, $\bar{x}$, mm	67.5	66.9	74.1	53.7	-	47.4
Std. dev., S_x, mm	20.7	24.7	9.2	7.4	-	12.8
Coeff.of variation, V, %	30.7	36.9	12.4	13.8	-	27.0
Requirement, mm	30 ± 10	30 ± 10	60 ± 10	30 ± 10	-	30 ± 10
% within limits	8.1	10.9	32.2	3.2	-	26.5
	Concrete Pavement					
Number of tests, n					477	
Mean $\bar{x}$, mm	-	-	-	-	55.4	-
Std. dev., S_x, mm	-	-	-	-	22.9	-
Coeff.of variation, V, %	-	-	-	-	41.3	-
Requirement, mm	-	-	-	-	30 ± 10	-
% Within limit	-	-	-	-	19.1	-

TABLE B: Results of the Air Content Tests

	Construction Year					
	1981		1982			
	Contract Number					
	80-73	81-54	81-05	81-102	82-01	82-67
	Lean Concrete Base					
Number of tests, n	57	109	306	443	108	694
Mean, $\bar{x}$, %	6.09	5.74	8.50	8.17	7.17	8.30
Std. deviation, S_x, % points	0.83	0.81	1.01	0.80	0.80	0.78
Coeff.of variation, V, %	13.6	14.1	11.9	9.8	11.2	9.4
Requirement, %	8.0 ± 2.0					
% within limit	54.0	37.5	92.6	98.6	92.8	98.4
	Concrete Base					
Number of tests, n	120	114	339	553	-	662
Mean, $\bar{x}$, %	4.04	3.74	6.27	5.92	-	6.29
Std. deviation, S_x, % points	0.65	0.64	0.67	0.84	-	0.76
Coeff.of variation, V, %	16.1	17.1	10.7	14.2	-	12.1
Requirement, %	6.0 ± 1.5					
% within limit	23.4	11.7	96.3	92.4		93.5
	Concrete Pavement					
Number of tests, n	-	-	-	-	477	-
Mean, $\bar{x}$, %	-	-	-	-	5.98	-
Std. deviation, S_x, % points	-	-	-	-	1.00	-
Coeff.of variation, V, %	-	-	-	-	16.7	-
Requirement, %	-	-	-	-	6.0 ± 1.5	-
% within limit	-	-	-	-	86.6	-

TABLE C: Results of the Standard 28d Compressive Strength Tests

	Construction Year					
	1981		1982			
	Contract Number					
	80-73	81-54	81-05	81-102	82-01	82-67
	Lean Concrete Base					
Number of tests, n	57	109	64	47	16	44
Mean, $\bar{x}$, MPa	19.1	18.4	18.8	20.9	15.2	18.3
Std. dev., S_x, MPa	1.69	2.53	2.87	2.22	2.67	1.95
Coeff. of variation, V, %	8.8	13.8	15.3	10.6	17.6	10.7
Requirement, MPa	min. 10.0					
% within limit	100.0	100.0	100.0	100.0	97.4	100.0
	Concrete Base					
Number of tests, n	119	110	61	50	-	60
Mean, $\bar{x}$, MPa	32.7	37.6	35.7	32.9	-	35.0
Std. dev., S_x, MPa	3.01	3.16	3.58	2.43	-	2.97
Coeff. of variation, V, %	9.2	8.4	10.0	7.4	-	8.5
Requirement, MPa	The average of all groups of three consecutive tests shall be $\geq$25.0 MPa and each individual strength test shall be $\geq$21.5 MPa					
% within limit	100.0	100.0	100.0	100.0	-	100.0
	Concrete Pavement					
Number of tests, n	-	-	-	-	67	-
Mean, $\bar{x}$, MPa	-	-	-	-	35.7	-
Std. dev., S_x, MPa	-	-	-	-	4.10	-
Coeff. of variation, V, %	-	-	-	-	11.5	-
Requirement, MPa	The average of all groups of three consecutive tests shall be $\geq$25.0 MPa and each individual test shall be $\geq$21.5 MPa.					
% within limit	-	-	-	-	100.0	-

TABLE D: Results of the Core Compressive Strength Tests

	Construction Year					
	1981		1982			
	Contract Number					
	80-73	81-54	81-05	81-102	82-01	82-67
	Lean Concrete Base					
Number of tests, n	116	107	35	93	46	114
Mean, $\bar{x}$, MPa	29.6	23.9	19.3	22.1	18.8	22.9
Std. deviation, S_x, MPa	4.23	3.74	3.47	3.97	2.31	3.28
Coeff.of variation, V, %	14.3	15.6	18.0	18.0	12.3	14.3
Requirement, MPa						
% within limit						
	Concrete Base					
Number of tests, n	118	112	37	93	-	114
Mean, $\bar{x}$, MPa	37.3	42.8	32.5	33.7	-	36.4
Std. deviation, S_x, MPa	4.03	3.95	3.78	5.11	-	4.03
Coeff.of variation, V, %	10.8	9.2	11.6	15.2	-	11.1
Requirement, MPa						
% within limit						
	Concrete Pavement					
Number of tests, n					119	
Mean, $\bar{x}$, MPa					36.8	
Std. deviation, S_x, MPa					3.82	
Coeff.of variation, V, %					10.4	
Requirement, MPa						
% within limit						

TABLE E: Results of the Core Length Tests

	Construction Year					
	1981		1982			
	Contract Number					
	80-73	81-54	81-05	81-102	82-01	82-67
	Lean Concrete Base					
Number of tests, n	116	107	37	93	46	114
Mean, $\bar{x}$, mm	136.8	136.6	144.7	134.6	131.6	130.0
Std. dev., S_x, mm	16.4	17.2	22.1	15.8	14.3	15.6
Coeff.of variation, V, %	12.0	12.6	15.3	11.7	10.9	12.0
Requirement, mm	127 ± 20	127 ± 20	152 ± 20	127 ± 20	127 ± 20	127 ± 20
% within limit	69.8	68.5	60.9	74.3	81.7	79.2
	Concrete Base					
Number of tests, n	118	113	37	93	-	114
Mean $\bar{x}$, mm	177.1	174.1	205.9	175.5	-	179.7
Std. dev., S_x, mm	12.1	15.1	9.3	10.4	-	11.0
Coeff.of variation, V, %	6.8	8.7	4.5	5.9	-	6.1
Requirement, mm	178 ± 16	178 ± 16	203 ± 16	178 ± 16	-	178 ± 16
% within limit	81.3	68.4	89.9	86.6	-	84.9
	Concrete Pavement					
Number of tests, n	-	-	-	Contract 82-01		
				40	44	35
Mean, $\bar{x}$, mm	-	-	-	179.2	200.9	305.6
Std. dev., S_x, mm	-	-	-	9.1	16.9	12.9
Coeff.of variation, V, %	-	-	-	5.1	8.4	4.2
Requirement, mm	-	-	-	178 ± 12	203 ± 12	305 ± 12
% within limit	-	-	-	80.8	51.9	65.1

TABLE F: Profile Index, Contract 82-01, Hwy. 3N

Station		Profile Count					Profile Index, in./mi.																				
		Wheel path					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheel path					Wheel path					Wheel path					Wheel path				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
1+ 50	4+ 00	3.5	4.5	3.5	11.5	5.8	7.4	9.5	7.4	24.3	12.2															
4+ 00	6+ 50	0.0	1.0	3.5	4.5	2.3	0.0	2.1	7.4	9.5	4.8															
6+ 50	9+ 00	0.5	1.0	1.5	1.5	1.1	1.1	2.1	3.2	3.2	2.4															
9+ 00	11+ 50	0.0	0.5	1.0	0.0	0.4	0.0	1.1	2.1	0.0	0.8															
11+ 50	14+ 00	2.5	(1) 5.5	(1) 6.0	(1) 11.0	6.3	5.3	11.6	12.7	23.2	13.2	1.6	4.2	6.3	9.0	5.3										
14+ 00	16+ 50	(1) 6.5	(3) 11.5	(4) 18.0	(5) 20.5	14.1	13.7	24.3	38.0	43.3	29.8						Sept. 8/82					4.6	8.4	11.8	17.2	10.5
16+ 50	19+ 00	1.0	2.0	1.0	2.5	1.6	2.1	4.2	2.1	5.3	3.4															
19+ 00	21+ 50	0.0	1.0	2.0	6.5	2.4	0.0	2.1	4.2	13.7	5.0															
21+ 50	24+ 00	1.0	3.0	4.5	(1) 9.0	4.4	2.1	6.3	9.5	19.0	9.2	4.5	9.2	13.5	20.3	11.9										
24+ 00	26+ 50	0.5	3.0	0.0	2.5	1.5	1.1	6.3	0.0	5.3	3.2															
26+ 50	29+ 00	1.0	3.5	3.5	6.0	3.5	2.1	7.4	7.4	12.7	7.4															
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																			
		Wheel path					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheel path					Wheel path					Wheel path					Wheel path				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
29+ 00	31+ 50	0.0	4.5	(2) 3.5	(2) 3.5	2.9	0.0	9.5	7.4	7.4	6.1															
31+ 50	34+ 00	0.5	9.0	2.5	(1) 7.5	4.9	1.1	19.0	5.3	15.8	10.3	1.1	10.6	5.0	10.3	6.8										
34+ 00	36+ 50	2.5	3.5	6.0	(3) 12.5	6.1	5.3	7.4	12.7	26.4	13.0															
36+ 50	37+ 25	3.5	(2) 3.0	(2) 4.0	2.0																					
37+ 25	39+ 00	0.5	2.0	6.0	(1) 6.0	6.8	8.4	10.6	21.1	16.9	14.3															
39+ 00	41+ 50	1.0	(1) 5.0	(1) 8.0	(1) 11.5	6.4	2.1	10.6	16.9	24.3	13.5															
41+ 50	44+ 00	1.5	4.0	3.0	6.0	3.6	3.2	8.4	6.3	12.7	7.7	4.8	9.2	14.3	20.1	12.1	3.0	8.3	9.8	14.9	9.0					
44+ 00	45+ 82	2.0	2.0	4.0	(1) 6.0																					
45+ 82	46+ 50	(1) 4.5	(1) 5.5	(1) 4.0	1.5	7.4	13.7	15.8	16.9	15.8	15.6															
		Note: Number in brackets in Profile Count is the bump count.																								

Sept. 9/82

Sept. 10/82

Station		Profile Count					Profile Index, in./mi.																				
		Wheel path					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheel path					Wheel path					Wheel path					Wheel path				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
46+ 50	49+ 00	0.5	3.0	(1) 5.5	8.0	4.3	1.1	6.3	11.6	16.9	9.0															
49+ 00	51+ 50	1.0	1.5	5.0	6.5	3.5	2.1	3.2	10.6	13.7	7.4															
51+ 50	54+ 00	0.0	1.0	2.0	3.5	1.6	0.0	2.1	4.2	7.4	3.4	4.2	6.9	10.8	13.5	8.9										
54+ 00	56+ 50	1.5	4.5	(1) 7.0	(1) 8.0	5.3	3.2	9.5	14.8	16.9	11.1															
56+ 50	59+ 00	2.0	2.5	4.0	8.5	4.3	4.2	5.3	8.4	18.0	9.0															
59+ 00	61+ 50	(1) 4.5	(1) 5.0	(2) 5.0	(2) 5.0	4.9	9.5	10.6	10.6	10.6	10.3															
61+ 50	64+ 00	0.0	0.0	2.5	3.0	1.4	0.0	0.0	5.3	6.3	2.9	4.2	6.3	9.8	12.9	8.3										
64+ 00	65+ 77	0.5	2.5	5.0	3.5							--	--	--	--	--	--	--	Sept. 13/82		--	3.8	6.7	10.6	12.6	8.4
65+ 77	66+ 50	(1) 7.5	(1) 3.0	(1) 3.5	(1) 6.5	8.0	16.9	11.6	18.0	21.1	16.9															
66+ 50	69+ 00	2.5	1.5	2.5	5.0	2.9	5.3	3.2	5.3	10.6	6.1															
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																				
		Wheel path					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheel path					Wheel path					Wheel path					Wheel path				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
69+ 00	71+ 50	(1) 3.0	(1) 4.0	9.0	8.0	6.0	6.3	8.4	19.0	16.9	12.7															
71+ 50	74+ 00	2.0	3.5	6.0	(1) 6.5	4.5	4.2	7.4	12.7	13.7	9.5	8.2	7.7	13.7	15.6	11.3										
74+ 00	76+ 50	1.0	0.5	2.0	1.0	1.1	2.1	1.1	4.2	2.1	2.4															
76+ 50	79+ 00	3.0	3.5	6.0	(1) 10.0	5.6	6.3	7.4	12.7	21.1	11.9															
79+ 00	81+ 50	4.0	3.0	(1) 5.5	(1) 8.0	5.1	8.4	6.3	11.6	16.9	10.8															
81+ 50	84+ 00	7.5	5.0	3.0	4.0	4.9	15.8	10.6	6.3	8.4	10.3	8.2	6.3	8.7	12.1	8.8	6.2	6.8	10.8	13.5	9.3					
84+ 00	84+ 74	3.0	1.5	2.5	4.0							--	--	--	--	--	--	Sept. 14/82			--	9.3	7.1	11.1	14.8	10.6
84+ 74	86+ 50	2.5	2.0	3.0	(1) 3.5	5.5	11.6	7.4	11.6	15.8	11.6															
86+ 50	89+ 00	5.5	5.0	5.0	6.0	5.4	11.6	10.6	10.6	12.7	11.4															
89+ 00	91+ 50	6.5	(2) 15.0	(4) 21.0	(4) 27.5	17.5	13.7	31.7	44.4	58.1	37.0															
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																				
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
91+ 50	94+ 00	2.5	5.0	(2) 9.0	(3) 16.5	8.3	5.3	10.6	19.0	34.8	17.4	10.6	15.0	21.4	30.4	19.4										
94+ 00	96+ 50	1.0	5.0	(2) 5.5	(2) 14.5	6.5	2.1	10.6	11.6	30.6	13.7															
96+ 50	99+ 00	1.0	3.0	3.0	8.0	3.8	2.1	6.3	6.3	16.9	7.9															
99+ 00	101+ 50	2.5	2.0	0.5	5.5	2.6	5.3	4.2	1.1	11.6	5.6															
101+ 50	104+ 00	0.5	6.0	7.5	(2) 12.5	6.6	1.1	12.7	15.8	26.4	14.0	2.6	8.4	8.7	21.4	10.3										
104+ 00	106+ 50	1.0	4.5	(2) 6.5	(2) 14.5	6.6	2.1	9.5	13.7	30.6	14.0															
106+ 50	109+ 25	2.5	(1) 12.5	(2) 15.5	(4) 24.0																	5.5	12.9	16.5	28.5	15.9
109+ 25	109+ 50	1.0	2.0	0.5	0.0	14.5	6.2	25.5	28.2	42.2	[1] 25.5	--	--	--	--	--	--	Sept. 15/82			--					
109+ 50	112+ 00	4.5	7.5	(2) 12.5	(2) 18.0	10.6	9.5	15.8	26.4	38.0	22.4															

Note: Number in brackets in Profile Count is the bump count.

[1] 300 ft. section

Station		Profile Count					Profile Index, in./mi.																				
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
112+ 00	114+ 50	2.0	(1) 5.5	(1) 9.5	(2) 14.5	7.9	4.2	11.6	20.1	30.6	16.6	5.5	16.1	22.4	35.7	[6] 19.9										
114+ 50	117+ 00	1.5	3.5	6.0	(2) 15.0	6.5	3.2	7.4	12.7	31.7	13.8															
117+ 00	119+ 50	2.0	(1) 3.0	(1) 11.0	(2) 12.0	7.0	4.2	6.3	23.2	25.3	14.8															
119+ 50	122+ 00	2.0	7.0	9.0	(1) 16.0	8.5	4.2	14.8	19.0	33.8	14.3															
122+ 00	124+ 50	4.5	6.0	7.5	(2) 13.5	7.9	9.5	12.7	15.8	28.5	16.6	5.3	10.3	17.7	29.8	15.8	6.0	12.5	17.6	29.4	[11] 16.4					
124+ 50	127+ 00	1.0	4.5	10.0	(2) 13.0	7.1	2.1	9.5	21.1	27.5	15.1															
127+ 00	129+ 50	0.0	1.0	7.0	6.5	3.6	0.0	2.1	14.8	13.7	7.7															
129+ 50	132+ 00	2.5	(2) 9.5	(2) 20.0	(3) 24.0	14.0	5.3	20.1	42.1	50.7	29.6															
132+ 00	134+ 50	3.0	(1) 10.5	(2) 14.0	(3) 23.5	12.8	6.3	22.2	29.6	49.6	26.9	3.4	13.5	26.9	35.4	19.8										

Note: Number in brackets in Profile Count is the bump count.

[6] 1050 ft. section

[11] 4050 ft. section

Station		Profile Count					Profile Index, in./mi.																			
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
134+ 50	134+ 87	0.0	1.5	0.5	1.5							--	--	--	--	--	--	Sept. 16/82			--	4.9	12.7	22.2	32.5	18.1
134+ 87	137+ 00	6.5	6.0	8.5	15.0	9.9	13.7	15.8	19.0	34.8	20.8															
137+ 00	139+ 50	0.5	3.0	4.5	7.5	3.9	1.1	6.3	9.5	15.8	8.2															
139+ 50	142+ 00	4.5	(1) 11.0	(3) 19.5	(4) 20.0	13.8	9.5	23.2	41.2	42.2	29.0															
142+ 00	144+ 50	2.0	1.0	0.5	3.5	1.8	4.2	2.1	1.1	7.4	3.7	7.1	11.9	17.7	25.1	15.5										
144+ 50	147+ 00	1.0	1.5	3.5	(1) 4.0	2.5	2.1	3.2	7.4	8.4	5.3															
147+ 00	149+ 50	2.0	1.5	(1) 3.0	(1) 8.0	3.6	4.2	3.2	6.3	16.9	7.7															
149+ 50	152+ 00	2.0	(1) 5.5	(2) 9.5	(2) 12.0	7.3	4.2	11.6	20.1	25.3	15.3															
152+ 00	154+ 50	0.0	1.0	2.0	4.5	1.9	0.0	2.1	4.2	9.5	4.0	2.6	5.0	9.5	15.0	8.0										
154+ 50	157+ 00	1.5	3.5	(2) 8.0	(3) 12.0	6.3	3.2	7.4	16.9	25.3	13.2															
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																				
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
157+ 00	159+ 50	3.5	2.0	4.5	(1) 6.0	4.0	7.4	4.2	9.5	12.7	8.5															
159+ 50	162+ 00	2.0	(1) 6.0	(3) 9.5	(3) 13.5	7.8	4.2	12.7	20.1	28.5	16.4															
162+ 00	162+ 75	1.5	2.0	2.5	2.0													Sept. 17/82				5.1	8.3	14.3	20.5	12.1
162+ 75	164+ 50	(1) 5.0	(1) 8.5	(1) 19.0	(1) 18.0	14.6	13.7	22.2	45.4	42.2	30.9	7.1	11.6	23.0	27.2	17.2	5.1	10.5	19.3	25.7	15.2					
164+ 50	167+ 00	2.5	3.5	4.0	3.0	3.3	5.3	7.4	8.4	6.3	6.9															
167+ 00	169+ 50	0.5	2.0	2.5	4.5	2.4	1.1	4.2	5.3	9.5	5.0															
169+ 50	172+ 00	0.5	1.0	0.0	3.5	1.3	1.1	2.1	0.0	7.4	2.7															
172+ 00	174+ 50	0.0	(1) 3.0	(1) 4.0	(1) 6.5	3.4	0.0	6.3	8.4	13.7	7.1	1.8	5.0	5.5	9.2	5.4										
174+ 50	177+ 00	0.0	1.0	1.5	(1) 5.0	1.9	0.0	2.1	3.2	10.6	4.0															
177+ 00	179+ 50	0.0	0.5	0.0	5.0	1.4	0.0	1.1	0.0	10.6	2.9															
179+ 50	182+ 00	0.5	2.5	2.0	2.0	1.8	1.1	5.3	4.2	4.2	3.7															
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																			
		Wheel path					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheel path					Wheel path					Wheel path					Wheel path				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
182+ 00	183+ 12	1.0	(1) 2.0	(1) 3.0	(1) 3.5													Sept. 18/82				2.6	6.2	9.3	13.2	7.8
183+ 12	184+ 50	1.5	3.0	2.0	3.5	4.9	5.3	10.6	10.6	14.8	10.3	1.6	4.8	4.5	10.0	5.2	—	—	—	—	—					
184+ 50	187+ 00	0.0	3.5	4.0	5.5	3.3	0.0	7.4	8.4	11.6	6.9															
187+ 00	189+ 50	0.0	(1) 4.5	3.0	3.5	2.8	0.0	9.5	6.3	7.4	5.8															
189+ 50	192+ 00	2.5	3.0	1.5	3.5	2.6	5.3	6.3	3.2	7.4	5.6															
192+ 00	194+ 50	1.5	2.5	2.5	3.0	2.4	3.2	5.3	5.3	6.3	5.0	2.1	7.1	5.8	8.2	5.8										
194+ 50	197+ 00	(1) 5.5	(2) 6.0	(3) 11.5	(3) 17.5	10.1	11.6	12.7	24.3	37.0	21.4															
197+ 00	199+ 50	1.5	1.0	3.0	3.5	2.3	3.2	2.1	6.3	7.4	4.8															
199+ 50	202+ 00	1.5	2.0	4.0	9.0	4.1	3.2	4.2	8.4	19.0	8.7															
202+ 00	204+ 50	0.0	2.0	1.5	2.5	1.5	0.0	4.2	3.2	5.3	3.2	4.5	5.8	10.6	17.2	9.5	2.5	5.7	6.6	11.2	6.5					
204+ 50	207+ 00	2.0	2.0	1.0	1.5	1.6	4.2	4.2	2.1	3.2	3.4															
207+ 00	209+ 50	0.0	3.0	0.5	0.5	1.0	0.0	6.3	1.1	1.1	2.1															
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																			
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
209+ 50	212+ 00	0.0	3.5	1.0	1.5	1.5	0.0	7.4	2.1	3.2	3.2															
212+ 00	214+ 50	0.0	2.0	3.5	2.0	1.9	0.0	4.2	7.4	4.2	4.0	1.1	5.5	3.2	2.9	3.2										
214+ 50	217+ 00	(1) 8.5	(1) 9.5	(2) 10.0	(2) 11.5	9.9	18.0	20.1	21.1	24.3	20.9															
217+ 00	219+ 50	1.0	(1) 6.5	3.5	6.0	4.3	2.1	13.7	7.4	12.7	9.0															
219+ 50	222+ 00	0.0	0.5	1.0	3.0	1.1	0.0	1.1	2.1	6.3	2.4															
222+ 00	224+ 50	0.0	0.5	2.5	(1) 7.5	2.6	0.0	1.1	5.3	15.8	5.6	5.0	9.0	9.0	14.8	9.5										
224+ 50	226+ 25	2.0	(2) 7.5	(2) 8.5	(2) 10.0																					
226+ 25	227+ 00	0.5	1.0	1.0	1.5	8.0	5.3	18.0	20.1	24.3	16.9	--	--	--	--	--	--	Sept. 20/82			--	3.4	7.7	7.9	11.6	7.7
227+ 00	229+ 50	1.0	3.5	3.5	4.0	3.0	2.1	7.4	7.4	8.4	6.3															
229+ 50	230+ 50																									
230+ 50	0+ 00	0.0	2.5	3.0	4.5	2.5	0.0	5.3	6.3	9.5	5.3															
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																				
		Wheel path					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheel path					Wheel path					Wheel path					Wheel path				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
01+ 50	4+ 00	0.0	0.0	1.0	1.5	0.6	0.0	0.0	2.1	3.2	1.3	1.8	7.7	9.0	11.4	7.5										
4+ 00	6+ 50	0.0	0.5	2.0	3.5	1.5	0.0	1.1	4.2	7.4	3.2															
6+ 50	9+ 00	0.0	0.5	2.0	4.0	1.6	0.0	1.1	4.2	8.4	3.4															
9+ 00	11+ 50	0.0	2.0	3.0	2.5	1.9	0.0	4.2	6.3	5.3	4.0															
11+ 50	14+ 00	0.0	2.5	4.0	3.5	2.5	0.0	5.3	8.4	7.4	5.3	0.0	2.9	5.8	7.1	4.0	2.0	6.3	6.7	9.0	6.0					
14+ 00	16+ 50	0.0	0.5	0.5	1.5	0.6	0.0	1.1	1.1	3.2	1.4															
16+ 50	19+ 00	0.5	0.0	2.0	3.0	1.4	1.1	0.0	4.2	6.3	2.9															
19+ 00	21+ 50	0.0	1.0	2.0	4.0	1.8	0.0	2.1	4.2	8.4	3.7															
21+ 50	24+ 00	0.0	1.0	0.5	2.0	0.9	0.0	2.1	1.1	4.2	1.9	0.3	1.3	2.6	5.5	2.4										
24+ 00	26+ 50	1.5	3.0	2.5	2.5	2.4	3.2	6.3	5.3	5.3	5.0															
26+ 50	29+ 00	2.5	(3) 6.5	(3) 13.5	(3) 16.0	9.6	5.3	13.7	28.5	33.8	20.3															
29+ 00	31+ 50	2.0	3.0	3.0	3.5	2.9	4.2	6.3	6.3	7.4	6.1															
31+ 50	34+ 00	0.0	1.5	0.5	1.0	0.8	0.0	3.2	1.1	2.1	1.6	3.2	7.4	10.3	12.1	8.3										
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																				
		Wheel path					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheel path					Wheel path					Wheel path					Wheel path				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
34+ 00	35+ 48	(1) 5.5	(1) 5.0	4.5	3.5																	1.8	4.5	6.4	8.2	5.2
35+ 48	36+ 50	0.5	0.0	2.5	1.5	5.8	12.7	10.6	14.8	10.6	12.2	--	--	--	--	--	--	Sept. 21/82			--					
36+ 50	39+ 00	0.5	1.0	1.5	1.0	1.0	1.1	2.1	3.2	2.1	2.1															
39+ 00	41+ 50	4.0	2.5	3.5	2.5	3.1	8.4	5.3	7.4	5.3	6.6															
41+ 50	44+ 00	0.0	0.5	2.5	3.0	1.5	0.0	1.1	5.3	6.3	3.2	5.5	4.8	7.7	6.1	6.0										
44+ 00	46+ 50	0.5	3.0	3.0	2.5	2.3	1.1	6.3	6.3	5.3	4.8															
46+ 50	49+ 00	2.0	3.0	1.5	2.5	2.3	4.2	6.3	3.2	5.3	4.8															
49+ 00	51+ 50	0.0	0.5	1.5	3.5	1.4	0.0	1.1	3.2	7.4	2.9															
51+ 50	54+ 00	2.5	(1) 4.5	3.0	2.0	3.0	5.3	9.5	6.3	4.2	6.3	2.6	5.8	4.8	5.5	4.7	2.9	4.8	6.3	7.3	5.3					
54+ 00	56+ 50	(1) 2.5	(1) 5.0	(1) 10.0	(1) 17.0	8.6	5.3	10.6	21.1	35.9	18.2															
56+ 50	59+ 00	1.0	4.0	4.0	2.0	2.8	2.1	8.4	8.4	4.2	5.8															
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																				
		Wheelpath					250 ft. Wheelpath					1,000 ft. Wheelpath					4,000 ft. Wheelpath					One day's paving Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
59+ 00	61+ 50	2.0	3.5	4.5	(1) 7.5	4.4	4.2	7.4	9.5	15.8	9.2															
61+ 50	64+ 00	0.5	3.5	4.0	6.0	3.5	1.1	7.4	8.4	12.7	7.4	3.2	8.4	11.9	17.2	10.2										
64+ 00	64+ 58	0.5	2.0	1.0	5.5							--	--	--	--	--	--	--	Sept. 22/82		--	3.0	6.0	7.7	10.3	6.8
64+ 58	66+ 50	3.0	(1) 7.0	4.5	(1) 7.5	7.8	7.4	19.0	11.6	27.5	16.4															
66+ 50	69+ 00	0.0	1.5	7.5	8.5	4.4	0.0	3.2	15.8	18.0	9.3															
69+ 00	71+ 50	0.5	1.5	3.0	4.5	2.4	1.1	3.2	6.3	9.5	5.0															
71+ 50	74+ 00	0.0	2.0	1.0	0.5	0.9	0.0	4.2	2.1	1.1	1.9	2.1	7.4	9.0	14.0	8.1										
74+ 00	76+ 50	3.5	(3) 10.5	(3) 12.0	6.0	8.0	7.4	22.2	25.3	12.7	16.9															
76+ 50	79+ 00	3.5	5.5	6.0	7.0	5.5	7.4	11.6	12.7	14.8	11.6															
79+ 00	81+ 50	(1) 4.5	(1) 7.0	8.0	4.5	6.0	9.5	14.8	16.9	9.5	12.7															
81+ 50	84+ 00	3.5	7.5	6.5	8.0	6.4	7.4	15.8	13.7	16.9	13.5	7.9	16.1	17.2	13.5	13.7										
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																				
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
84+ 00	86+ 50	3.5	4.0	(1) 10.0	(1) 12.5	7.5	7.4	8.4	21.1	26.4	15.8															
86+ 50	89+ 00	5.0	3.0	3.5	7.0	4.6	10.6	6.3	7.4	14.8	9.8															
89+ 00	91+ 50	2.0	4.5	7.0	4.5	4.5	4.2	9.5	14.8	9.5	9.5															
91+ 50	94+ 00	0.0	1.0	1.0	1.0	0.8	0.0	2.1	2.1	2.1	1.6	5.5	6.6	11.4	13.2	9.2	4.7	9.6	12.3	14.5	10.3					
94+ 00	95+ 04	0.0	1.0	2.5	3.0													Sept. 23/82				5.0	9.7	12.6	12.9	10.1
95+ 04	96+ 50	0.0	3.0	0.9	0.5	6.0	0.0	8.4	24.3	18.0	12.7	--	--	--	--	--	--	—			--					
96+ 50	99+ 00	1.0	1.0	1.5	2.5	1.5	2.1	2.1	3.2	5.3	3.2															
99+ 00	100+ 00	0.5	1.5	3.5	3.5	2.3	2.6	7.9	18.5	18.5	[2] 11.9	1.3	5.7	14.5	12.8	[7] 8.6		Sept. 24/82				1.6	5.9	14.9	12.2	8.7
100+ 00	101+ 50	(2) 8.0	(4) 16.0			12.0	28.2	56.3			[3] 42.3						--	—			--					
101+ 50	104+ 00	(2) 6.5	(1) 4.0			5.3	13.7	8.4			11.1															
104+ 00	106+ 50	3.0	5.0			4.0	6.3	10.6			8.5															

Note: Number in brackets in Profile Count is the bump count.

[2] 100 ft. section
[3] 150 ft. section

[7] 600 ft. section

Station		Profile Count					Profile Index, in./mi.																				
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
106+ 50	109+ 00	3.5	1.5			2.5	7.4	3.2			5.3	12.3	15.5			[8] 13.9										
109+ 00	111+ 50	(1) 4.0	0.5			2.3	8.4	1.1			4.8															
111+ 50	114+ 00	1.0	0.5			0.8	2.1	1.1			1.6															
114+ 00	116+ 50	2.0	0.5			1.3	4.2	1.1			2.7															
116+ 50	119+ 00	1.5	3.0			2.3	3.2	6.3			4.8	4.5	2.4			3.5										
119+ 00	121+ 50	0.5	0.0			0.3	1.1	0.0			0.6															
121+ 50	124+ 00	2.5	3.0			2.8	5.3	6.3			5.8															
124+ 00	125+ 20	0.0	0.0																							
125+ 20	126+ 50	0.0	(2) 4.0			2.0	0.0	8.4			4.2															
126+ 50	129+ 00	0.0	1.0			0.5	0.0	2.1			1.1	1.6	4.2			2.9										
129+ 00	130+ 95	0.0	(1) 2.5															Oct. 12/82				5.5	7.1			6.3
		Note: Number in brackets in Profile Count is the bump count.										[8] 900 ft. section														

Station		Profile Count					Profile Index, in./mi.																				
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
130+ 95	131+ 50	0.0	3.5			3.0	0.0	12.7			6.4															
131+ 50	134+ 00	1.5	3.0			2.3	3.2	6.3			4.8															
134+ 00	136+ 50	3.0	3.0			3.0	6.3	6.3			6.3															
136+ 50	139+ 00	2.5	3.5			3.0	5.3	7.4			6.4	3.7	8.2			6.0	5.3	7.4			[12] 6.4					
139+ 00	141+ 50	2.5	2.0			2.3	5.3	4.2			4.8															
141+ 50	144+ 00	4.0	1.0			2.5	8.4	2.1			5.3															
144+ 00	146+ 50	2.5	0.5			1.5	5.3	1.1			3.2															
146+ 50	149+ 00	5.0	2.0			3.5	10.6	4.2			7.4	7.4	2.9			5.2										
149+ 00	151+ 50	(1) 5.0	(1) 3.0			4.0	10.6	6.3			8.5															
151+ 50	154+ 00	3.5	4.0			3.8	7.4	8.4			7.9															
154+ 00	156+ 50	5.0	3.0			4.0	10.6	6.3			8.5															
156+ 50	159+ 00	5.0	0.0			2.5	10.6	0.0			5.3	9.8	5.3			7.6										

Note: Number in brackets in Profile Count is the bump count.

[12] 3900 ft. section

Station		Profile Count					Profile Index, in./mi.																			
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
159+ 00	161+ 50	3.0	0.0			1.5	6.3	0.0			3.2															
161+ 50	164+ 00	(1) 9.0	3.0			6.0	19.0	6.3			12.7															
164+ 00	166+ 50	4.0	3.0			3.5	8.4	6.3			7.4															
166+ 50	169+ 00	0.5	0.0			0.3	1.1	0.0			0.6	8.7	3.2			6.0										
169+ 00	171+ 50	6.0	2.0			4.0	12.7	4.2			8.5															
171+ 50	174+ 00	1.5	0.0			0.8	3.2	0.0			1.6															
174+ 00	176+ 50	0.5	2.5			1.5	1.1	5.3			3.2															
176+ 50	179+ 00	1.0	2.0			1.5	2.1	4.2			3.2	4.8	3.4			4.1	7.7	3.7			5.7					
179+ 00	181+ 50	3.5	1.0			2.3	7.4	2.1			4.8															
181+ 50	184+ 00	1.5	0.0			0.8	3.2	0.0			1.6															
184+ 00	186+ 50	0.5	1.5			1.0	1.1	3.2			2.2															
186+ 50	188+ 04	1.0	0.0														Oct. 13/82					6.6	4.0			5.3
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																				
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
188+ 04	189+ 00	0.5	(2) 4.5			3.0	3.2	9.5			6.4	3.7	3.7			3.7										
189+ 00	191+ 50	0.5	0.5			0.5	1.1	1.1			1.1															
191+ 50	194+ 100	0.0	1.5			0.8	0.0	3.2			1.6															
194+ 00	196+ 50	1.0	3.0			2.0	2.1	6.3			4.2															
196+ 50	199+ 00	3.0	(2) 6.0			4.5	6.3	12.7			9.5	2.4	5.8			4.1										
199+ 00	201+ 50	1.5	3.0			2.3	3.2	6.3			4.8															
201+ 50	204+ 00	2.0	0.5			1.3	4.2	1.1			2.7															
204+ 00	206+ 50	5.0	2.5			3.8	10.6	5.3			8.0															
206+ 50	209+ 00	4.0	2.0			3.0	8.4	4.2			6.3	6.6	4.2			5.4										
209+ 00	211+ 50	0.5	1.0			0.8	1.1	2.1			1.6															
211+ 50	214+ 00	(1) 3.5	2.5			3.0	7.4	5.3			6.4															
214+ 00	216+ 50	5.5	1.5			3.5	11.6	3.2			7.4															
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																			
		Wheel path					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheel path					Wheel path					Wheel path					Wheel path				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
216+ 50	219+ 00	9.5	6.0			7.8	20.1	12.7			16.4	10.0	5.8			7.9	5.7	4.9			5.3					
219+ 00	221+ 50	6.5	4.5			5.5	13.7	9.5			11.6															
221+ 50	224+ 00	3.5	0.5			2.0	7.4	1.1			4.3															
224+ 00	226+ 50	3.0	3.0			3.0	6.3	6.3			6.3															
226+ 50	229+ 00	4.0	7.5			5.8	8.4	15.8			12.1	9.0	8.2			8.6										
229+ 00	231+ 50	0.5	2.0			1.3	1.1	4.2			2.7															
231+ 50	234+ 00	3.5	5.0			4.3	7.4	10.6			9.0															
234+ 00	236+ 50	2.5	1.0			1.8	5.3	2.1			3.7															
236+ 50	239+ 00	5.0	2.5			3.8	10.6	5.3			8.0	6.1	5.5			5.8										
239+ 00	241+ 50	6.0	5.5			5.8	12.7	11.6			12.2															
241+ 50	244+ 00	1.5	2.0			1.8	3.2	4.2			3.7															
244+ 00	246+ 50	2.5	3.5			3.0	5.3	7.4			6.4															
246+ 50	249+ 00	7.5	(1) 11.5			9.5	15.8	24.3			20.1	9.2	11.9			10.6										
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																				
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
249+ 00	249+ 91	3.0	1.0																			7.3	7.2			7.3
249+ 91	251+ 50	5.0	2.5			5.8	16.9	7.4			12.2															
251+ 50	254+ 00	3.0	1.0			2.0	6.3	2.1			4.2															
254+ 00	256+ 50	3.5	2.5			3.0	7.4	5.3			6.4															
256+ 50	259+ 00	0.0	0.5			0.3	0.0	1.1			0.6	7.7	4.0			5.9	8.0	7.4			7.7					
259+ 00	261+ 50	4.0	1.0			2.5	8.4	2.1			5.3															
261+ 50	264+ 00	1.5	1.0			1.3	3.2	2.1			2.7															
264+ 00	266+ 50	(1) 7.5	(1) 8.0			7.8	15.8	16.9			16.4															
266+ 50	269+ 00	5.5	6.5			6.0	11.6	13.7			12.7	9.8	8.7			9.3										
269+ 00	271+ 50	2.5	2.5			2.5	5.3	5.3			5.3															
271+ 50	274+ 00	3.0	0.0			1.5	6.3	0.0			3.2															
274+ 00	276+ 50	3.0	0.5			1.8	6.3	1.1			3.7															

Oct. 14/82

Note: Number in brackets in Profile Count is the bump count.

Station		Profile Count					Profile Index, in./mi.																			
		Wheel path					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheel path					Wheel path					Wheel path					Wheel path				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
276+ 50	278+ 00	2.0	3.5			2.8	7.0	12.3			[4] 9.7	6.2	3.8			[9] 5.0	8.1	6.4			[13] 7.3	7.6	Oct. 15/82 5.5			6.6
278+ 00	276+ 50			1.5	3.0	2.3			3.2	6.3	[4] 4.8															
276+ 50	274+ 00			1.5	2.0	1.8			3.2	4.2	3.7															
274+ 00	271+ 50			2.0	4.0	3.0			4.2	8.4	6.3															
271+ 50	269+ 00			0.5	1.0	0.8			1.1	2.1	1.6			3.2	5.9	[9] 4.6										
269+ 00	266+ 50			2.0	(1) 6.0	4.0			4.2	12.7	8.5															
266+ 50	264+ 00			2.5	4.5	3.5			5.3	9.5	7.4															
264+ 00	261+ 50			0.0	0.5	0.3			0.0	1.0	0.6															
261+ 50	259+ 00			0.0	1.0	0.5			0.0	2.1	1.1			2.4	6.4	4.4										
259+ 00	256+ 50			0.5	2.0	1.3			1.1	4.2	2.7															
256+ 50	254+ 00			0.0	0.0	0.0			0.0	0.0	0.0															

Note: Number in brackets in Profile Count is the bump count.

[4] 150 ft. section

[9] 900 ft. section

[13] 1900 ft. section

Station		Profile Count					Profile Index, in./mi.																			
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
254+ 00	251+ 50			0.0	1.5	0.8			0.0	3.2	1.6															
251+ 50	249+ 00			2.0	2.5	2.3			4.2	5.3	4.8			1.3	3.2	2.3										
249+ 00	246+ 50			1.5	2.0	1.8			3.2	4.2	3.7															
246+ 50	244+ 00			0.0	5.5	2.8			0.0	11.6	5.8															
244+ 00	241+ 50			0.0	1.5	0.8			0.0	3.2	1.6															
241+ 50	240+ 96			4.5	5.5														Oct. 18/82					2.6	6.1	4.4
240+ 96	239+ 00			5.5	5.5	10.5			21.1	23.2	22.2			6.1	10.6	8.4			3.2	6.5	[14] 4.9					
239+ 00	236+ 50			0.0	1.0	0.5			0.0	2.1	1.1															
236+ 50	234+ 00			0.5	2.0	1.3			1.1	4.2	2.7															
234+ 00	231+ 50			1.0	4.5	2.8			2.1	9.5	5.8															
231+ 50	229+ 00			0.0	2.5	1.3			0.0	5.3	2.7			0.8	5.3	3.1										
229+ 00	226+ 50			0.0	0.5	0.3			0.0	1.1	0.6															
226+ 50	224+ 00			0.0	0.0	0.0			0.0	0.0	0.0															

Note: Number in brackets in Profile Count is the bump count.

Station		Profile Count					Profile Index, in./mi.																				
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
224+ 00	221+ 50			1.0	2.0	1.5			2.1	4.2	3.2															
221+ 50	219+ 00			0.0	1.0	0.5			0.0	2.1	1.1			0.5	1.8	1.2										
219+ 00	216+ 50			0.0	1.5	0.8			0.0	3.2	1.6															
216+ 50	214+ 00			1.5	0.0	0.8			3.2	0.0	1.6															
214+ 00	211+ 50			0.5	1.5	1.0			1.1	3.2	2.2															
211+ 50	209+ 00			0.0	4.0	2.0			0.0	8.4	4.2			1.1	3.7	2.4										
209+ 00	206+ 50			0.5	1.5	1.0			1.1	3.2	2.2															
206+ 50	204+ 00			1.5	1.0	1.3			3.2	2.1	2.7															
204+ 00	201+ 50			0.0	0.5	0.3			0.0	1.1	0.6															
201+ 50	199+ 00			0.0	0.0	0.0			0.0	0.0	0.0			1.1	1.6	1.4			0.9	3.1	2.0					
199+ 00	196+ 50			0.5	0.5	0.5			1.1	1.1	1.1															
196+ 50	194+ 00			2.0	2.0	2.0			4.2	4.2	4.2															
194+ 00	191+ 50			0.5	2.5	1.5			1.1	5.3	3.2															
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																			
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
194+ 00	191+ 50			0.5	2.5	1.5			1.1	5.3	3.2															
191+ 50	189+ 00			1.0	1.5	1.3			2.1	3.2	2.7			2.1	3.4	2.8										
189+ 00	186+ 50			2.0	1.5	1.8			4.2	3.2	3.7															
186+ 50	184+ 00			0.0	2.0	1.0			0.0	4.2	2.1															
184+ 00	181+ 50			0.0	1.5	0.8			0.0	3.2	1.6															
181+ 50	181+ 25			1.0	0.0																					
181+ 25	179+ 00			0.0	1.0	1.0			2.1	2.1	2.1	--	--	--	--	--	--	--	Oct. 19/82	--	--	--	--	1.7	3.6	2.7
179+ 00	176+ 50			(1) 2.0	(1) 5.5	3.8			4.2	11.6	7.9															
176+ 50	174+ 00			3.5	(3) 4.5	4.0			7.4	9.5	8.5															
174+ 00	171+ 50			(1) 2.0	(1) 3.0	2.5			4.2	6.3	5.3															
171+ 50	169+ 00			1.0	1.0	1.0			2.1	2.1	2.1			4.5	7.4	6.0										
169+ 00	166+ 50			0.0	0.5	0.3			0.0	1.1	0.6															
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																			
		Wheelpath					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheelpath					Wheelpath					Wheelpath					Wheelpath				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
166+ 50	164+ 00			0.0	1.0	0.5			0.0	2.1	1.1															
164+ 00	161+ 50			0.5	2.5	1.5			1.1	5.3	3.2															
161+ 50	159+ 00			0.5	1.5	1.0			1.1	3.2	2.2			0.5	2.9	1.7			2.2	4.2	3.2					
159+ 00	156+ 50			0.0	0.0	0.0			0.0	0.0	0.0															
156+ 50	154+ 00			0.0	1.5	0.8			0.0	3.2	1.6															
154+ 00	151+ 50			0.0	0.0	0.0			0.0	0.0	0.0															
151+ 50	149+ 00			0.5	1.0	0.8			1.1	2.1	1.6			0.3	1.3	0.8										
149+ 00	146+ 75			(1) 4.5	(1) 4.5							--	--	--	--	--	--	--	Oct. 20.82		--	--	--	2.2	4.2	3.2
146+ 75	146+ 50			0.0	0.0	4.5			9.5	9.5	9.5															
146+ 50	144+ 00			0.0	0.0	0.0			0.0	0.0	0.0															
144+ 00	141+ 50			0.0	0.5	0.3			0.0	1.1	0.6															
141+ 50	139+ 00			0.0	0.0	0.0			0.0	0.0	0.0			2.4	2.6	2.5										
139+ 00	136+ 50			0.0	0.0	0.0			0.0	0.0	0.0															
		Note: Number in brackets in Profile Count is the bump count.																								

Station		Profile Count					Profile Index, in./mi.																				
		Wheel path					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheel path					Wheel path					Wheel path					Wheel path				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
136+ 50	134+ 00			2.0	1.0	1.5			4.2	2.1	3.2															
134+ 00	131+ 50			1.5	1.5	1.5			3.2	3.2	3.2															
131+ 50	129+ 00			0.5	1.0	0.8			1.1	2.1	1.6			2.1	1.8	2.0										
129+ 00	126+ 50			0.0	1.0	0.5			0.0	2.1	1.1															
126+ 50	124+ 00			2.0	1.0	1.5			4.2	2.1	3.2								1.7	2.0	[15] 1.9					
124+ 00	121+ 50			0.0	2.5	1.3			0.0																	
121+ 50	119+ 00			2.0	2.0	2.0			4.2	4.2	4.2			2.1	3.4	2.8			1.7	2.3	2.0					
119+ 00	116+ 50			(1) 8.0	(1) 3.0	5.5			16.9	6.3	11.6															
116+ 50	114+ 00			2.5	0.0	1.3			5.3	0.0	2.7															
114+ 00	111+ 50			0.0	0.0	0.0			0.0	0.0	0.0															
111+ 50	109+ 00			0.0	1.0	0.5			0.0	2.1	1.1			5.5	2.1	3.8										
109+ 00	106+ 50			0.0	0.0	0.0			0.0	0.0	0.0															
		Note: Number in brackets in Profile Count is the bump count.															[15] 3500 ft. section									

Station		Profile Count					Profile Index, in./mi.																			
		Wheel path					250 ft.					1,000 ft.					4,000 ft.					One day's paving				
							Wheel path					Wheel path					Wheel path					Wheel path				
From	To	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.	1	2	3	4	avg.
106+ 50	104+ 00			0.0	1.0	0.5			0.0	2.1	1.1															
104+ 00	101+ 50			0.0	0.0	0.0			0.0	0.0	0.0															
101+ 50	100+ 00			5.5	7.5	6.5			11.6	15.8	[5] 13.7			3.2	5.0	[10] 4.1			4.4	3.5	[16] 4.0			Oct. 21/82 2.7	2.6	2.7
1+50 GS 0+00 GN	230+50GS 278+00GN	480.5	699.5	775.0	1113.	767.0								Final Profile Index for Contract 82-01 50,700 ft. of 2-lane pavement									5.0	7.3	8.1	11.6	8.0

Note: Number in brackets in Profile Count is the bump count.

[5] 150 ft. section

[10] 900 ft. section

[16] 1900 ft. section

TABLE G: Profile Index Test Results, Summary

	Section Traversed					
	1000 ft.		4000 ft.		One day's paving	
	Number of Wheelpath Averaged*					
	2	4	2	4	2	4
Number of sections, n	36	33	9	8	8	14
Mean profile index, in./mile x	4.78	9.72	4.93	9.75	4.81	9.99
Max. profile index	13.9	19.9	7.7	16.4	7.3	18.1
Min. profile index	0.8	2.4	1.9	5.3	2.7	5.2
Range, in./mile	13.1	17.5	5.8	11.1	4.6	12.9
Standard deviation, S_x, in./mile	2.88	4.75	2.15	4.13	1.83	3.51
Coeff.of variation, V, %	60.2	48.9	43.6	42.4	38.1	35.1

*Two lanes (four wheel paths) were placed with one pass of the paving train from Station 01+50 SG to 230+50 SG and 00+00 NG to 100+00 NG. One lane (two wheel paths) were placed from Station 100+00 NG to 278+00 NG and 278+00 NG to 124+00 NG

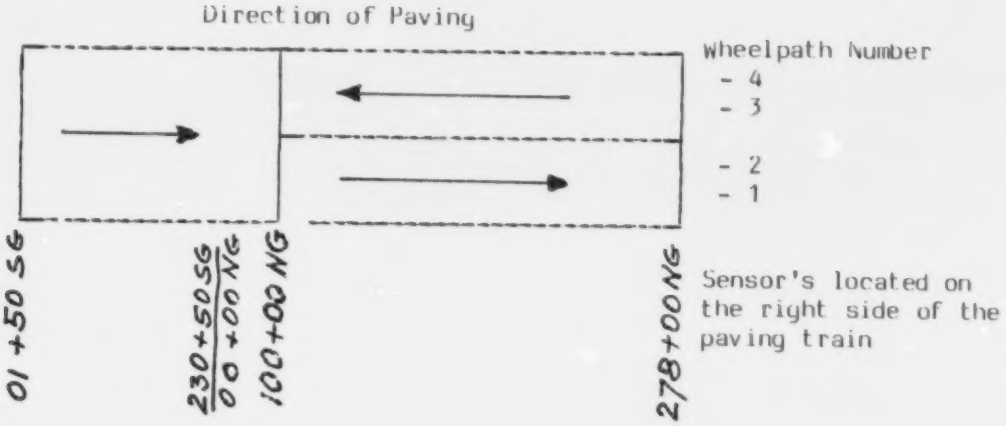


TABLE H: Percent Payment - Core Compressive Strength, Concrete Base

Lot No.	Core Compressive Strength, MPa					% Pay
	X_1	X_2	X_3	X_4	$\overline{X}$	
Contract 81-05, Specified Compressive Strength min. 2 5.0 MPa						
1	34.8	32.9	38.9	31.9	34.6	100
2	28.0	28.4	25.4	27.4	27.3	100
3	29.3	30.9	27.1	28.2	28.9	100
4	28.7	31.9	32.2	36.2	32.3	100
5	37.8	34.0	36.5	32.7	35.3	100
6	41.2	34.6	32.6	33.2	35.4	100
7	28.8	35.7	32.9	38.5	34.0	100
8	29.4	34.1	30.7	30.0	31.1	100
9	29.7	29.3	36.3	34.5	33.4	100
Contract 81-102 , Specified Compressive Strength min. 2 5.0 MPa						
1	26.9	22.4	25.1	29.4	25.95	100
2	26.3	38.4	22.6	22.9	27.55	100
3	25.5	22.8	31.5	31.0	27.7	100
4	31.9	20.6	21.3	28.3	25.5	100
5	29.5	32.2	33.2	29.6	31.1	100
6	24.6	33.0	30.0	30.9	29.6	100
7	34.2	34.0	34.3	38.5	35.25	100
8	38.2	35.7	36.4	33.3	35.9	100
9	31.5	34.0	36.2	35.3	34.25	100
10	33.3	28.0	43.1	32.4	34.2	100
11	35.8	31.3	32.4	39.5	34.75	100
12	38.1	37.5	34.4	39.4	37.35	100
13	33.4	36.0	32.4	36.2	34.5	100
14	43.0	38.1	37.5	38.1	39.2	100
15	42.2	34.8	39.5	37.1	38.4	100
16	36.8	40.6	35.3	36.0	37.2	100
17	32.4	38.3	35.6	33.5	34.95	100
18	41.2	46.9	33.1	37.1	39.6	100
19	36.3	33.7	33.4	35.7	34.8	100
20	34.6	32.0	35.6	33.4	33.9	100
21	33.1	40.0	38.6	34.5	36.55	100
22	40.7	33.2	36.0	38.2	37.0	100
23	29.8	32.3	29.2	31.1	30.6	100

TABLE I: Percent Payment - Slab Thickness, Lean Concrete Base

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	$\bar{X}$		
Contract 80-73, Specified Thickness = 127 mm							
1	132.0 (140.4)	125.9	121.9	132.0 (147.8)	128.0	+ 1.0	100
2	126.2	132.0 (139.9)	132.0 (140.2)	120.2	127.6	+ 0.6	100
3	104.7	121.6	132.0 (135.6)	132.0 (164.8)	122.6	- 4.4	99
4	129.9	132.0 (168.4)	132.0 (140.4)	132.0 (140.6)	131.5	+ 4.5	100
5	132.0 (146.7)	132.0 (158.7)	126.0	108.1	124.5	- 2.5	100
6	126.7	132.0 (132.1)	116.7	118.3	123.4	- 3.6	99
7	117.0	132.0 (146.1)	132.0 (150.9)	112.1	123.3	- 3.7	99
8	132.0 (135.7)	108.8	132.0 (150.7)	122.6	123.8	- 3.2	99
9	132.0 (157.7)	112.9	127.8	132.0 (132.9)	126.2	- 0.8	100
10	116.3	130.4	132.0 (178.1)	118.3	124.2	- 2.8	100
11	128.0	132.0 (156.6)	132.0 (139.9)	132.0 (145.8)	131.0	+ 4.0	100
12	121.4	132.0 (134.0)	126.2	132.0 (156.3)	127.9	+ 0.9	100
13	132.0 (149.8)	114.6	132.0 (153.1)	132.0 (139.7)	127.6	+ 0.6	100
14	132.0 (135.7)	132.0 (144.9)	127.2	124.4	128.9	+ 1.9	100
15	132.0 (158.9)	132.0 (143.4)	127.4	132.0 (146.4)	130.8	+ 3.8	100
16	113.7	132.0 (127.8)	132.0 (149.3)	132.0 (132.8)	127.4	+ 0.4	100

132.0 = maximum length credited (specified length + 5.0 mm)
(140.4) = acutal length

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	$\overline{X}$		
Contract 80-73, Specified Thickness = 127 mm							
17	132.0 (162.4)	132.0 (139.8)	132.0 (135.8)	132.0 (136.4)	132.0	+ 5.0	100
18	132.0 (137.9)	132.0 (145.4)	126.1	132.0 (133.2)	130.5	+ 3.5	100
19	132.0 (140.2)	132.0 (183.9)	132.0 (161.4)	132.0 (145.4)	132.0	+ 5.0	100
20	132.0 (136.0)	132.0 (150.8)	132.0 (145.3)	118.0	128.5	+ 1.5	100
21	132.0 (134.8)	131.0	119.2	120.9	125.8	- 1.2	100
22	132.0 (156.4)	132.0 (143.9)	132.0 (146.6)	125.6	130.4	+ 3.4	100
23	122.7	132.0 (142.3)	132.0 (166.8)	107.9	123.6	- 3.4	99
24	104.7	131.7	103.4	132.0 (140.4)	118.0	- 9.0	97
25	125.7	120.9	132.0 (139.8)	132.0 (159.0)	127.6	+ 0.6	100
26	132.0 (151.7)	126.8	128.1	132.0 (145.9)	129.7	+ 2.7	100
27	132.0 (134.8)	132.0 (158.8)	132.0 (138.1)	132.0 (165.0)	132.0	+ 5.0	100
28	132.0 (142.9)	132.0 (170.7)	125.6	132.0 (138.3)	130.4	+ 3.4	100
29	132.0 (161.7)	132.0 (133.1)	132.0 (139.3)	132.0 (134.4)	132.0	+ 5.0	100
Contract 81-54, Specified Thickness = 127 mm							
1	132.0 (145.1)	132.0 (158.4)	132.0 (140.9)	130.2	131.6	+ 4.6	100
2	132.0 (163.1)	132.0 (146.9)	132.0 (139.3)	132.0 (133.7)	132.0	+ 5.0	100
3	132.0	132.0	132.0	132.0	132.0	+ 5.0	100

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	$\overline{X}$		
Contract 81-54, Specified Thickness = 127 mm							
4	132.0 (156.0)	118.4	128.3	114.0	123.2	- 3.8	99
5	123.2	122.0	132.0 (137.0)	132.0 (155.9)	127.3	+ 0.3	100
6	132.0 (160.7)	132.0 (146.2)	127.0	132.0 (133.4)	130.8	+ 3.8	100
7	132.0 (150.8)	132.0 (140.7)	132.0 (147.0)	112.8	127.2	+ 0.2	100
8	132.0 (134.7)	132.0 (132.7)	115.9	118.7	124.6	- 2.4	100
9	100.6	119.9	132.0 (140.8)	132.0 (138.7)	121.1	- 5.9	99
10	132.0 (135.4)	116.2	124.0	128.1	125.1	- 1.9	100
11	116.7	132.0 (153.0)	132.0 (151.2)	132.0 (154.1)	128.2	+ 1.2	100
12	111.7	125.8	132.0 (138.9)	132.0 (133.7)	125.4	- 1.6	100
13	132.0 (139.9)	115.7	130.9	132.0 (135.1)	127.6	+ 0.6	100
14	132.0 (145.0)	132.0 (200.1)	118.9	131.9	128.7	+ 1.7	100
15	102.6	132.0 (144.0)	113.3	119.7	116.9	-10.1	94
16	132.0 (144.4)	118.9	132.0 (147.8)	132.0 (155.7)	128.7	+ 1.7	100
17	132.0 (133.0)	132.0 (150.4)	132.0 (138.1)	132.0 (147.0)	132.0	+ 5.0	100
18	130.8	132.0 (153.0)	112.6	132.0 (154.0)	126.8	- 0.2	100
19	132.0 (137.7)	132.0 (148.3)	124.0	120.2	127.0	0.0	100

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	$\overline{X}$		
Contract 81-54, Specified Thickness = 127 mm							
20	132.0 (148.6)	132.0 (173.4)	132.0 (135.7)	132.0 (156.9)	132.0	+ 5.0	100
21	132.0 (165.2)	132.0 (154.1)	132.0 (146.2)	132.0 (141.8)	132.0	+ 5.0	100
22	132.0 (144.9)	132.0 (148.7)	132.0 (132.2)	91.1	121.8	- 5.2	99
23	126.1	132.0 (146.8)	132.0 (151.9)	132.0 (138.0)	130.5	+ 3.5	100
24	132.0 (146.8)	132.0 (140.6)	132.0 (152.1)	132.0 (144.7)	132.0	+ 5.0	100
25	132.0 (135.8)	119.8	125.4	124.6	125.4	- 1.6	100
26	132.0 (150.7)	99.3	106.1	132.0 (148.4)	117.4	- 9.6	94
27	131.4	132.0 (137.1)	112.1		125.2	- 1.8	100
Contract 81-05, Specified Thickness = 152 mm							
1	117.5	147.5	125.0	135.0	131.3	-20.7	83
2	125.0	107.5	135.0	140.0	126.9	-25.1	75
3	157.0 (180.0)	132.5	157.0 (172.5)	155.0	150.4	- 1.6	100
4	157.0 (162.5)	157.0 (157.5)	157.0 (157.5)	157.0 (177.5)	157.0	+ 5.0	100
5	135.0	125.0	110.0	147.5	129.4	-22.6	75
6	135.0	155.0	132.5	145.0	141.9	-10.1	94
7	130.0	157.0 (200.0)	150.0	157.0 (175.0)	148.5	- 3.5	99
8	120.0	125.0	155.0	135.0	133.8	-18.2	83
9	115.0 147.5	157.0 (177.5)	137.5	157.0 (175.0)	142.8	- 9.2	94

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	$\overline{X}$		
Contract 81-102, Specified Thickness = 127 mm							
1	132.0 (145.0)	105.0	132.0 (132.5)	132.0 (165.0)	125.2	- 1.8	100
2	132.0 (155.0)	122.5	132.0 (155.0)	122.5	127.2	+ 0.2	100
3	127.5	120.0	125.0	115.0	121.9	- 5.1	99
4	132.0 (145.0)	132.0 (132.5)	132.0 (142.5)	132.0 (132.5)	132.0	+ 5.0	100
5	112.5	132.0 (140.0)	132.0 (140.0)	100.0	119.1	- 7.9	97
6	132.0 (165.0)	132.0 (142.5)	132.0 (145.0)	130.0	131.5	+ 4.5	100
7	132.0 (142.5)	132.0 (145.0)	132.0 (142.5)	132.0 (145.0)	132.0	+ 5.0	100
8	127.5	132.0 (172.5)	132.0 (142.5)	132.0 (140.0)	130.9	+ 3.9	100
9	132.0 (147.5)	122.5	132.0 (135.0)	132.0 (140.0)	129.6	+ 2.6	100
10	132.0 (137.5)	102.5	132.0 (137.5)	132.0 (190.0)	124.6	- 2.4	100
11	132.0 (135.0)	125.0	132.0 (132.5)	132.0 (142.5)	130.2	+ 3.2	100
12	132.0 (142.5)	125.0	120.0	132.0 (150.0)	127.2	+ 0.2	100
13	132.0 (135.0)	132.0 (132.5)	132.0 (137.5)	122.5	129.6	+ 2.6	100
14	110.0	120.0	132.0 (147.5)	127.5	122.4	- 4.6	99
15	132.0 (135.0)	132.0 (137.5)	132.0 (142.5)	132.0 (140.0)	132.0	+ 5.0	100
16	130.0	132.0 (157.5)	130.0	125.0	129.2	+ 2.2	100

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	$\overline{X}$		
Contract 81-102, Specified Thickness = 127 mm							
17	117.5	132.0 (132.5)	130.0	122.5	125.5	- 1.5	100
18	115.0	115.0	132.0 (152.5)	120.0	120.5	- 6.5	97
19	110.0	112.5	132.0 (135.0)	132.0 (140.0)	121.6	- 5.4	99
20	132.0 (152.5)	132.0 (155.0)	132.0 (147.5)	132.0 (157.5)	132.0	+ 5.0	100
21	132.0 (145.0)	125.0	130.0	132.0 (157.5)	129.8	+ 2.8	100
22	120.0	117.5	125.0	132.0 (152.5)	123.6	- 3.4	99
23	132.0 (137.5) 130.0	132.0 (142.5)	132.0 (132.5)	120.0	129.2	+ 2.2	100
Contract 82-01, Specified Thickness = 127 mm							
1	125.0	132.0 (140.0)	120.0	132.0 (160.0)	127.3	+ 0.3	100
2	132.0 (145.0)	122.5	132.0 (142.5)	132.0 (135.0)	129.6	+ 2.6	100
3	132.0 (132.5)	132.0 (132.5)	132.0 (142.5)	125.0	130.3	+ 3.3	100
4	132.0 (145.0)	130.0	132.0 (150.0)	132.0 (132.5)	131.5	+ 4.5	100
5	132.0 (157.5)	105.0	125.0	127.5	122.4	- 4.6	99
6	122.5	132.0 (160.0)	132.0 (147.5)	132.0 (132.5)	129.6	+ 2.6	100
7	117.5	117.5	122.5	120.0	119.4	- 7.6	97
8	97.5	120.0	105.0	107.5	107.5	-19.5	83

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	$\overline{X}$		
Contract 82-01, Specified Thickness = 127 mm							
9	132.0 (132.5)	130.0	127.5	132.0 (135.0)	130.4	+ 3.4	100
10	132.0 (132.5)	122.5	132.0 (135.0)	132.0 (145.0)	129.6	+ 2.6	100
11	132.0 (150.0) 132.0 (147.5)	130.0 132.0 (147.5)	132.0 (132.5)	120.0	129.7	+ 2.7	100
Contract 82-67, Specified Thickness = 127 mm							
1	132.0 (170.0)	125.0	132.0 (140.0)	132.0 (132.5)	130.2	+ 3.2	100
2	132.0 (167.5)	132.0 (155.0)	117.5	132.0 (167.5)	128.4	+ 1.4	100
3	132.0 (150.0)	130.0	130.0	117.5	127.4	+ 0.4	100
4	130.0	122.5	132.0 (137.5)	117.5	125.5	- 1.5	100
5	132.0 (135.0)	130.0	132.0 (135.0)	117.5	127.9	+ 0.9	100
6	132.0 (135.0)	132.0 (142.5)	132.0 (135.0)	107.5	125.9	- 1.1	100
7	132.0 (142.5)	105.0	122.5	95.0	113.6	-13.4	94
8	125.0	125.0	115.0	125.0	122.5	- 4.5	99
9	127.5	130.0	120.0	115.0	123.1	- 3.9	99
10	127.5	112.5	117.5	132.0 (135.0)	122.4	- 4.6	97
11	132.0 (140.0)	132.0 (170.0)	132.0 (157.5)	132.0 (140.0)	132.0	+ 5.0	100
12	132.0 (142.5)	132.0 (140.0)	132.0 (140.0)	110.0	126.5	- 0.5	100

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	$\overline{X}$		
Contract 82-67, Specified Thickness = 127 mm							
13	132.0 (137.5)	125.0	120.0	132.0 (162.5)	127.3	+ 0.3	100
14	102.5	132.0 (145.0)	102.5	125.0	115.5	-11.5	94
15	122.5	132.0 (132.5)	132.0 (135.0)	132.0 (145.0)	129.6	+ 2.6	100
16	115.0	130.0	132.0 (142.5)	132.0 (145.0)	127.2	+ 0.2	100
17	110.0	122.5	125.0	117.5	118.8	- 8.2	97
18	127.5	130.0	132.0 (137.5)	115.0	126.1	- 0.9	100
19	117.5	115.0	132.0 (135.0)	115.0	119.9	- 7.1	97
20	132.0 (132.5)	130.0	120.0	125.0	126.8	- 0.2	100
21	132.0 (135.0)	132.0 (137.5)	120.0	132.0 (140.0)	129.0	+ 2.0	100
22	102.5	120.0	115.0	130.0	116.9	-10.1	94
23	130.0	132.0 (132.5)	132.0 (150.0)	132.0 (177.5)	131.5	+ 4.5	100
24	130.0	132.0 (132.5)	110.0	127.5	124.9	- 2.1	100
25	120.0	127.5	127.5	132.0 (132.5)	126.8	- 0.2	100
26	112.5	132.0 (142.5)	125.0	132.0 (135.0)	125.4	- 1.6	100
27	132.0 (135.0)	117.5	120.0	130.0	124.9	- 2.1	100
28	132.0 (142.5)	102.5	117.5	132.0 (140.0)			
	132.0 (167.5)	132.0 (145.0)			124.7	- 2.3	100

TABLE J: Percent Payment - Slab Thickness, Concrete Base

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	X		
Contract 80-73, Specified Thickness = 178 mm							
1	183.0 (187.7)	183.0 (186.0)	183.0 (191.0)	183.0 (191.3)	183.0	+ 5.0	100
2	183.0 (200.4)	183.0 (189.8)	183.0 (187.2)	183.0 (196.7)	183.0	+ 5.0	100
3	183.0 (203.1)	183.0 (192.4)	174.9	183.0 (184.2)	181.0	+ 3.0	100
4	182.6	177.7	166.9	180.0	176.8	- 1.2	100
5	183.0 (191.0)	183.0 (187.1)	183.0 (197.8)	183.0 (202.6)	183.0	+ 5.0	100
6	183.0 (187.7)	183.0 (185.1)	183.0 (195.3)	183.0 (193.7)	183.0	+ 5.0	100
7	179.6	183.0 (202.4)	169.2	183.0 (184.2)	178.7	+ 0.7	100
8	170.4	180.7	164.6	175.0	172.7	- 5.3	99
9	181.3	171.2	182.3	171.1	176.5	- 1.5	100
10	153.4	175.6	169.6	168.0	166.6	-11.5	94
11	160.4	170.9	162.2	183.0 (184.7)	169.1	- 8.9	97
12	177.9	160.4	183.0 (186.4)	170.9	173.0	- 5.0	99
13	179.8	183.0 (184.4)	172.1	172.0	176.7	- 1.3	100
14	159.8	183.0 (192.7)	170.1	169.3	170.6	- 7.4	97
15	152.0	176.3	151.3	166.0	161.4	-16.6	89
16	174.4	166.7	180.2	176.0	174.3	- 3.7	99
17	176.8	179.4	180.0	172.9	177.3	- 0.7	100
18	140.7	183.0 (190.0)	183.0 (189.4)	183.0 (195.1)	172.4	- 5.6	99

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	X		
Contract 80-73, Specified Thickness = 178 mm							
19	183.0 (190.3)	183.0 (193.9)	170.4	164.0	175.1	- 2.9	100
20	164.3	179.8	171.4	160.2	168.9	- 9.1	94
21	181.7	175.6	162.3	183.0 (184.7)	175.6	- 2.4	100
22	183.0 (188.8)	169.3	166.0	183.0 (203.9)	175.3	- 2.7	100
23	171.4	160.0	160.3	177.6	167.3	-10.7	94
24	183.0 (187.0)	179.1	171.1	167.8	175.2	- 2.8	100
25	166.3	173.1	183.0 (184.6)	160.4	170.7	- 7.3	97
26	181.8	170.3	171.6	164.2	172.0	- 6.0	99
27	172.6	162.0	173.0	162.6	167.6	-10.4	94
28	169.4	183.0 (189.9)	178.3	176.7	176.8	- 1.2	100
29	176.9 169.1	183.0 (185.2) 181.7	181.3	174.8	177.8	- 0.2	100
Contract 81-54, Specified Thickness = 178 mm							
1	146.0	174.0	159.0	177.0	164.0	-14.0	89
2	165.0	173.0	164.0	162.1	166.0	-12.0	94
3	175.3	163.3	155.7	168.0	165.6	-12.4	94
4	177.8	167.4	174.7	165.0	171.2	- 6.8	97
5	165.4	163.4	161.3	154.3	161.1	-16.9	89
6	174.7	168.2	164.8	182.4	172.5	- 5.5	99
7	162.8	174.8	170.4	171.0	169.8	- 8.2	97

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	X		
Contract 81-54, Specified Thickness = 178 mm							
8	168.6	145.0	153.0	158.0	156.2	-21.8	83
9	165.4	156.0	183.0 (187.0)	155.4	165.0	-13.0	94
10	170.8	151.0	175.1	151.3	162.0	-16.0	89
11	171.8	170.1	171.0	172.0	171.2	- 6.8	97
12	182.6	182.0	183.0 (189.4)	175.6	180.8	+ 2.8	100
13	168.0	182.0	172.8	183.0 (185.2)	176.4	- 1.6	100
14	176.8	166.2	176.6	183.0 (198.6)	175.6	- 2.4	100
15	179.1	183.0 (197.3)	178.3	174.1	178.6	+ 0.6	100
16	167.1	183.0 (280.0)	163.2	174.6	172.0	- 6.0	99
17	169.9	175.8	160.0	178.7	171.1	- 6.9	97
18	176.2	170.0	180.1	180.6	176.7	- 1.3	100
19	165.0	169.0	171.0	176.0	170.2	- 7.8	97
20	162.0	183.0 (183.9)	173.4	178.1	174.1	- 3.9	99
21	169.7	183.0 (199.2)	175.0	172.8	175.1	- 2.9	100
22	156.0	176.6	169.1	183.0 (194.0)	171.2	- 6.8	97
23	183.0 (188.0)	183.0 (188.2)	180.2	180.3 (185.1)	181.6	+ 3.6	100
24	182.1	183.0 (190.1)	180.1	183.0 (193.6)	182.0	+ 4.0	100
25	175.0	183.0 (203.2)	180.0	177.6	178.9	+ 0.9	100

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	X		
Contract 81-54, Specified Thickness = 178 mm							
26	181.3	178.0	183.0 (184.0)	165.4	176.9	- 1.1	100
27	180.3	175.0	174.8	180.9	177.8	- 0.2	100
28	170.0	183.0 (189.4)	181.0	152.0	171.5	- 6.5	97
Contract 81-05, Specified Thickness 203 mm							
1	208.0 (232.5)	197.5	190.0	197.5	198.3	- 4.7	99
2	182.5	202.5	208.0 (225.0)	208.0 (212.5)	200.2	- 2.8	100
3	202.5	200.0	205.0	207.5	203.8	+ 0.8	100
4	202.5	207.5	208.0 (212.5)	202.5	205.1	+ 2.1	100
5	207.5	205.0	208.0 (212.5)	202.5	205.8	+ 2.8	100
6	208.0 (212.5)	208.0 (212.5)	207.5	208.0 (212.5)	207.9	+ 4.9	100
7	208.0 (212.5)	208.0 (215.0)	208.0 (217.5)	202.5	206.6	+ 3.6	100
8	197.5	202.5	205.0	200.0	201.2	- 1.8	100
9	205.0 207.5	187.5	205.0	208.0 (210.0)	202.6	- 0.4	100

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	X		
Contract 81-102, Specified Thickness = 178 mm							
1	165.0	165.0	160.0	183.0 (185.0)	168.2	- 9.8	94
2	183.0 (207.5)	183.0 (192.5)	177.5	183.0 (190.0)	181.6	+ 3.6	100
3	160.0	183.0 (185.0)	183.0 (185.0)	165.0	172.8	- 5.2	99
4	177.5	183.0 (185.0)	155.0	183.0 (185.0)	174.6	- 3.4	99
5	175.0	170.0	170.0	165.0	170.0	- 8.0	97
6	165.0	177.5	183.0 (185.0)	180.0	176.4	- 1.6	100
7	172.5	180.0	167.5	180.0	175.0	- 3.0	100
8	175.0	182.5	183.0 (185.0)	170.0	177.6	- 0.4	100
9	182.5	175.0	180.0	183.0 (187.5)	180.1	+ 2.1	100
10	170.0	172.5	177.5	162.5	170.6	- 7.4	97
11	183.0 (185.0)	180.0	180.0	145.0	172.0	- 6.0	99
12	172.5	183.0 (190.0)	180.0	183.0 (192.5)	179.6	+ 1.6	100
13	177.5	177.5	177.5	182.5	178.8	+ 0.8	100
14	183.0 (190.0)	170.0	135.0	167.5	163.9	-14.1	89
15	165.0	172.5	167.5	175.0	170.0	- 8.0	97
16	165.0	170.0	170.0	167.5	168.1	- 9.9	94
17	182.5	177.5	180.0	160.0	175.0	- 3.0	100
18	170.0	183.0 (187.5)	167.5	175.0	173.9	- 4.1	99
19	175.0	167.5	180.0	180.0	175.6	- 2.4	100

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	X		
Contract 81-102, Specified Thickness = 178 mm							
20	183.0 (185.0)	167.5	180.0	177.5	177.0	- 1.0	100
21	182.5	182.5	170.0	180.0	178.8	+ 0.8	100
22	170.0	165.0	170.0	172.5	169.4	- 8.6	97
23	183.0 (185.0) 182.5	180.0	180.0	175.0	180.1	+ 2.1	100
Contract 82-67, Specified Thickness = 178 mm							
1	162.5	180.0	150.0	183.0 (190.0)	168.9	- 9.1	94
2	183.0 (185.0)	157.5	183.0 (185.0)	180.0	175.2	- 2.8	100
3	183.0 (185.0)	172.5	183.0 (185.0)	170.0	177.1	- 0.9	100
4	180.0	183.0 (185.0)	183.0 (185.0)	182.5	182.1	+ 4.1	100
5	182.5	183.0 (190.0)	183.0 (190.0)	183.0 (185.0)	182.9	+ 4.9	100
6	183.0 (190.0)	183.0 (192.5)	177.5	183.0 (185.0)	181.6	+ 3.6	100
7	180.0	183.0 (185.0)	167.5	183.0 (192.5)	178.4	+ 0.4	100
8	182.5	182.5	172.5	183.0 (185.0)	180.1	+ 2.1	100
9	180.0	180.0	165.0	172.5	174.4	- 3.6	99
10	182.5	180.0	175.0	183.0 (190.0)	180.1	+ 2.1	100
11	183.0 (187.5)	167.5	165.0	182.5	174.5	- 3.5	99

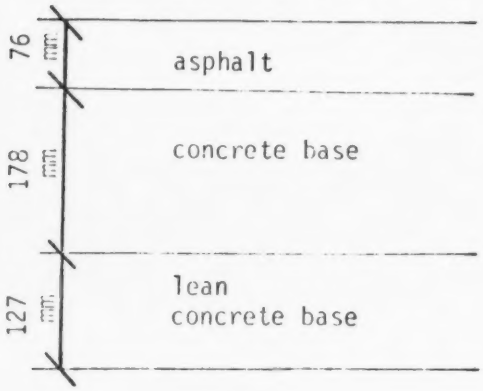
Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	X		
Contract 82-67, Specified Thickness = 178 mm							
12	183.0 (185.0)	177.5	172.5	172.5	176.4	- 1.5	100
13	183.0 (187.5)	183.0 (190.0)	177.5	180.0	180.9	+ 2.9	100
14	170.0	170.0	180.0	183.0 (192.5)	175.8	- 2.2	100
15	183.0 (200.0)	157.5	183.0 (190.0)	170.0	173.4	- 4.6	99
16	183.0 (192.5)	172.5	183.0 (202.5)	175.0	178.4	+ 0.4	100
17	183.0 (185.0)	182.5	172.5	177.5	178.9	+ 0.9	100
18	183.0 (202.5)	165.0	183.0 (187.5)	182.5	178.4	+ 0.4	100
19	182.5	177.5	182.5	183.0 (197.5)	181.4	+ 3.4	100
20	183.0 (185.0)	183.0 (187.5)	180.0	180.0	181.5	+ 3.5	100
21	182.5	170.0	180.0	167.5	175.0	- 3.0	100
22	183.0 (192.5)	167.5	182.5	172.5	176.4	- 1.6	100
23	180.0	162.5	183.0 (190.0)	130.0	163.9	-14.1	89
24	182.5	157.5	183.0 (195.0)	172.5	173.9	- 4.1	99
25	183.0 (190.0)	177.5	183.0 (185.0)	183.0 (197.5)	181.6	+ 3.1	100
26	183.0 (190.0)	172.5	170.0	162.5	172.0	- 6	99
27	167.5	182.5	182.5	177.5	177.5	- 0.5	100
28	170.0 175.0	183.0 (185.0) 172.5	175.0	162.5	173.0	- 5.0	99

TABLE K: Percent Payment - Slab Thickness, Concrete Pavement

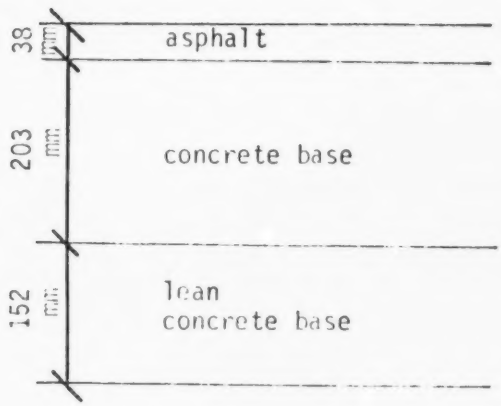
Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	$\bar{X}$		
Contract 82-01, Specified Thickness of 305 mm							
1	310.0 (315.0)	302.5	292.5	282.5	296.9	- 8.1	97
2	305.0	282.5	290.0	297.5	293.8	-11.2	94
3	295.0	292.5	295.0	310.0 (317.5)	298.1	- 6.9	97
4	290.0	295.0	310.0 (330.0)	310.0 (312.5)	301.3	- 3.7	99
5	310.0	305.0	310.0	310.0 (325.0)	308.8	+ 3.8	100
6	310.0 (337.5)	307.5	305.0	297.5	305.0	+ 0.0	100
7	292.5	310.0	310.0 (315.0)	310.0 (315.0)	305.6	+ 0.6	100
8	310.0 (317.5)	310.0 (317.5)	300.0	300.0	305.0	+ 0.0	100
9	305.0	307.5	310.0 (322.5)		305.0	+ 0.0	100
Contract 82-01, Specified Thickness of 203 mm							
1	208.0 (245.0)	195.0	207.5	208.0 (210.0)	204.6	+ 1.6	100
2	192.5	208.0 (210.0)	185.0	207.5	198.3	- 4.7	99
3	208.0 (240.0)	208.0 (230.0)	205.0	195.0	204.0	+ 1.0	100
4	208.0 (247.5)	208.0 (210.0)	208.0 (210.0)	192.5	204.1	+ 1.1	100
5	192.5	208.0 (212.5)	195.0	208.0 (212.5)	200.9	- 2.1	100
6	187.5	182.5	195.0	180.0	186.3	-16.7	89
7	190.0	180.0	185.0	202.5	189.4	-13.6	89
8	area of removal 177.5	172.5	192.5	202.5	186.3	-16.7	89

Lot No.	Core Length, mm					Deficiency in Average Thickness, mm	% Payment
	X_1	X_2	X_3	X_4	$\bar{X}$		
Contract 82-01, Specified Thickness of 203 mm							
9	195.0	208.0 (212.5)	200.0	192.5	198.9	- 4.1	99
10	208.0 (225.0)	202.5	195.0	200.0	201.4	- 2.6	100
11	180.0	195.0	202.5	197.5	193.8	- 9.2	94
Contract 82-01, Specified Thickness of 178 mm							
1	177.5	177.5	183.0 (185.0)	175.0	178.3	+ 0.3	100
2	180.0	183.0 (190.0)	183.0 (187.5)	183.0 (187.5)	182.3	+ 4.3	100
3	183.0 (207.5)	180.0	183.0 (185.0)	157.5	175.9	- 2.1	100
4	182.5	172.5	175.0	180.0	177.5	- 0.5	100
5	182.5	182.5	183.0 (185.0)	183.0 (185.0)	182.8	+ 4.8	100
6	170.0	180.0	182.5	157.5	172.5	- 5.5	99
7	167.5	177.5	172.5	183.0 (185.0)	175.1	- 2.9	100
8	183.0 (185.0)	183.0 (185.0)	182.5	175.0	180.9	+ 2.9	100
9	183.0 (185.0)	165.0	162.5	182.5	173.3	- 4.7	99
10	180.0	180.0	175.0	182.5	179.4	+ 1.4	100

Contract 80-73, 81-54,
81-102 and 82-67

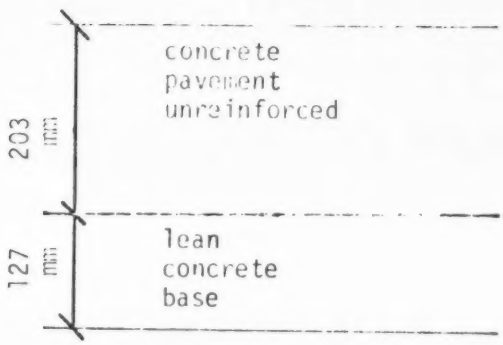


Contract 81-05

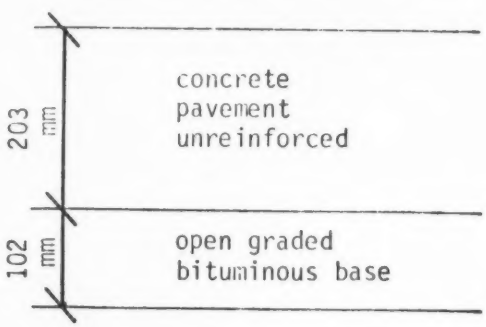


Contract 82-01

Contract 82-01



Contract 82-01



Contract 82-01

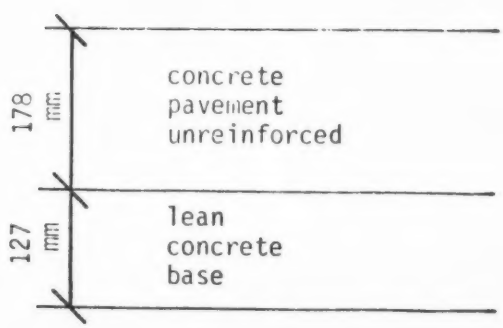


Fig. 1 Pavement Structures

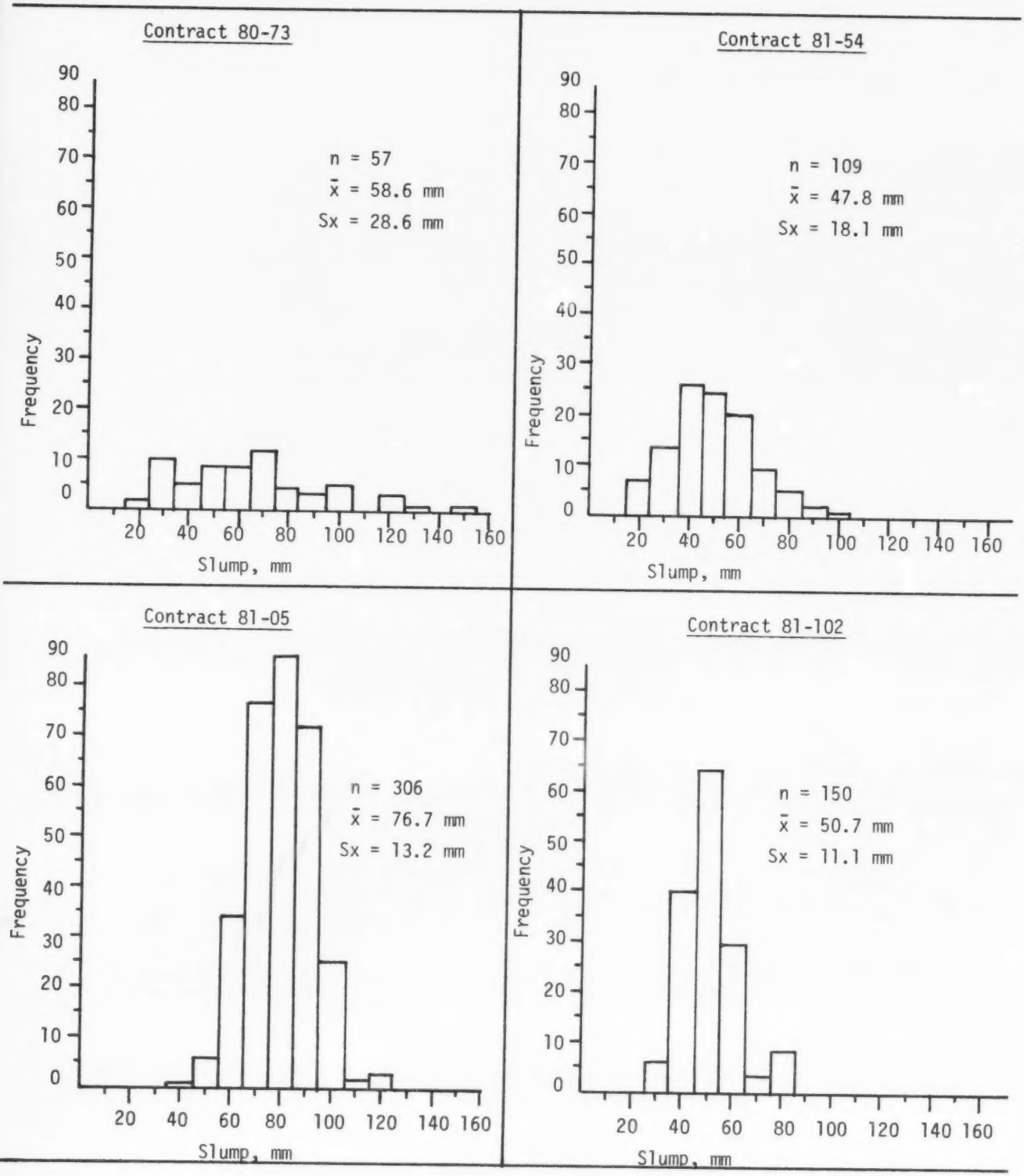


Fig. 2 (a) - Slump Test Results, Frequency Histograms, Lean Concrete Base

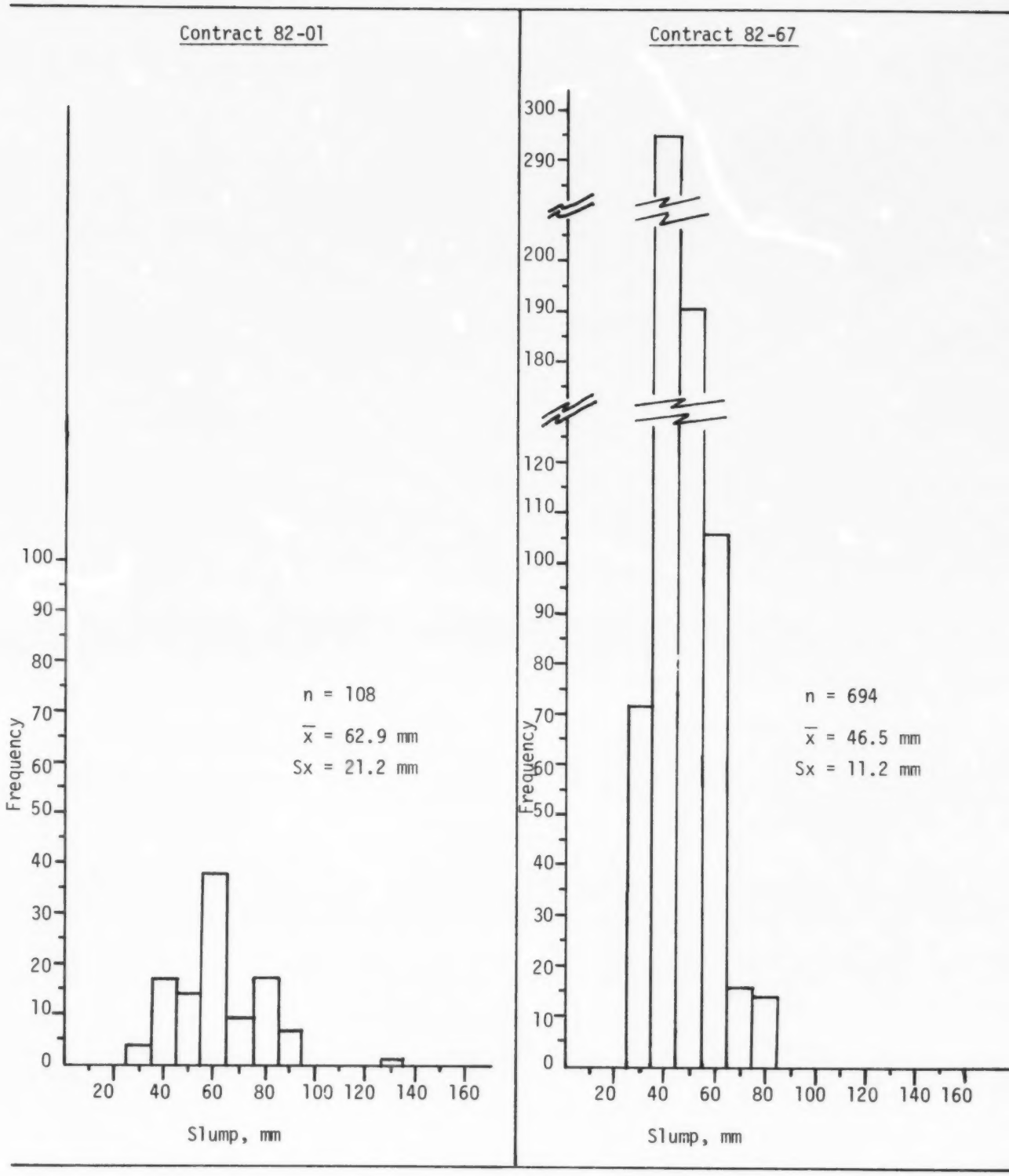


Fig. 2 (b) - Slump Test Results, Frequency Histograms,
Lean Concrete Base

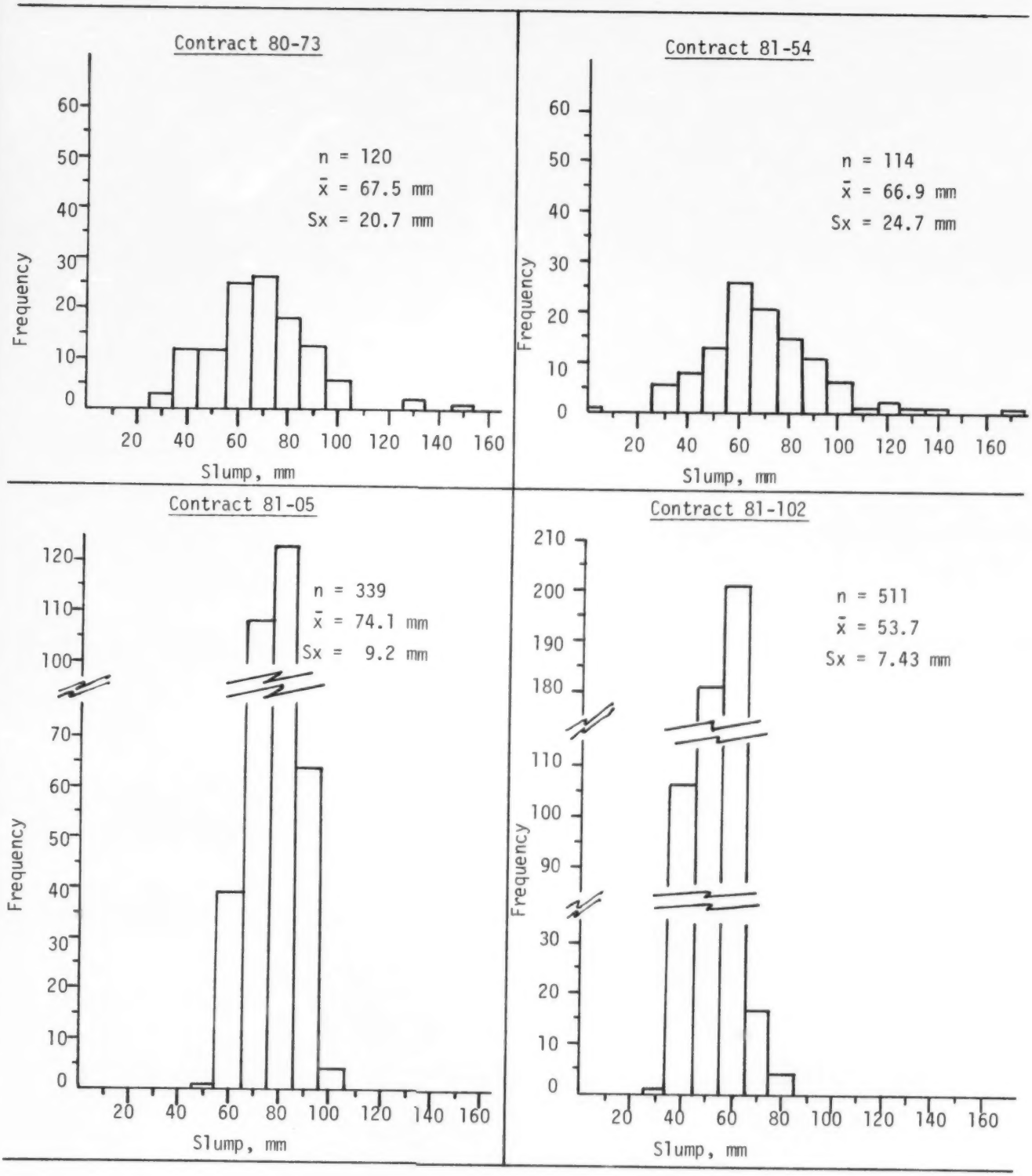


Fig. 3 (a) - Slump Test Results, Frequency Histograms, Concrete Base

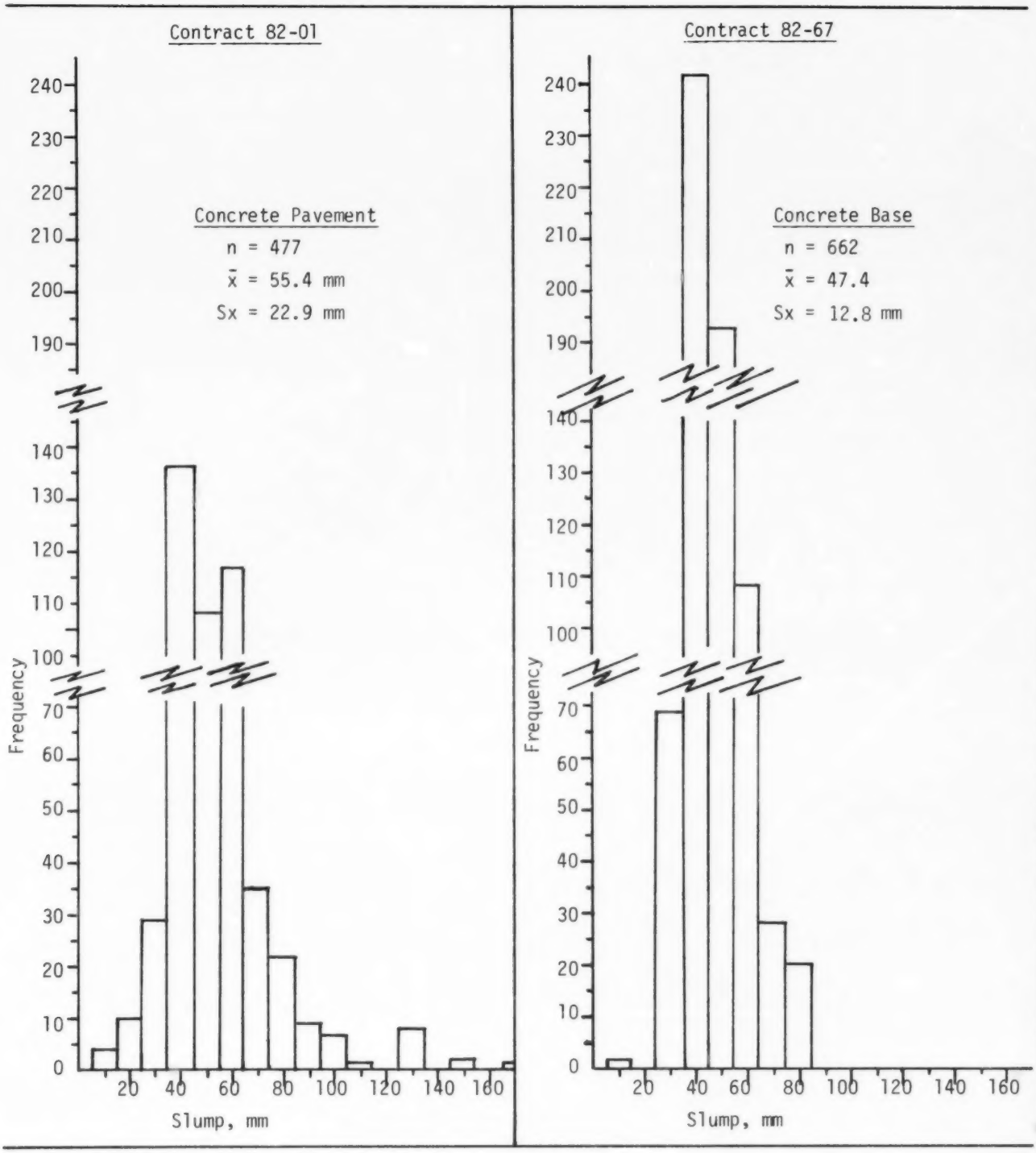


Fig. 3 (b) Slump Test Results, Frequency Histograms, Concrete Base and Pavement

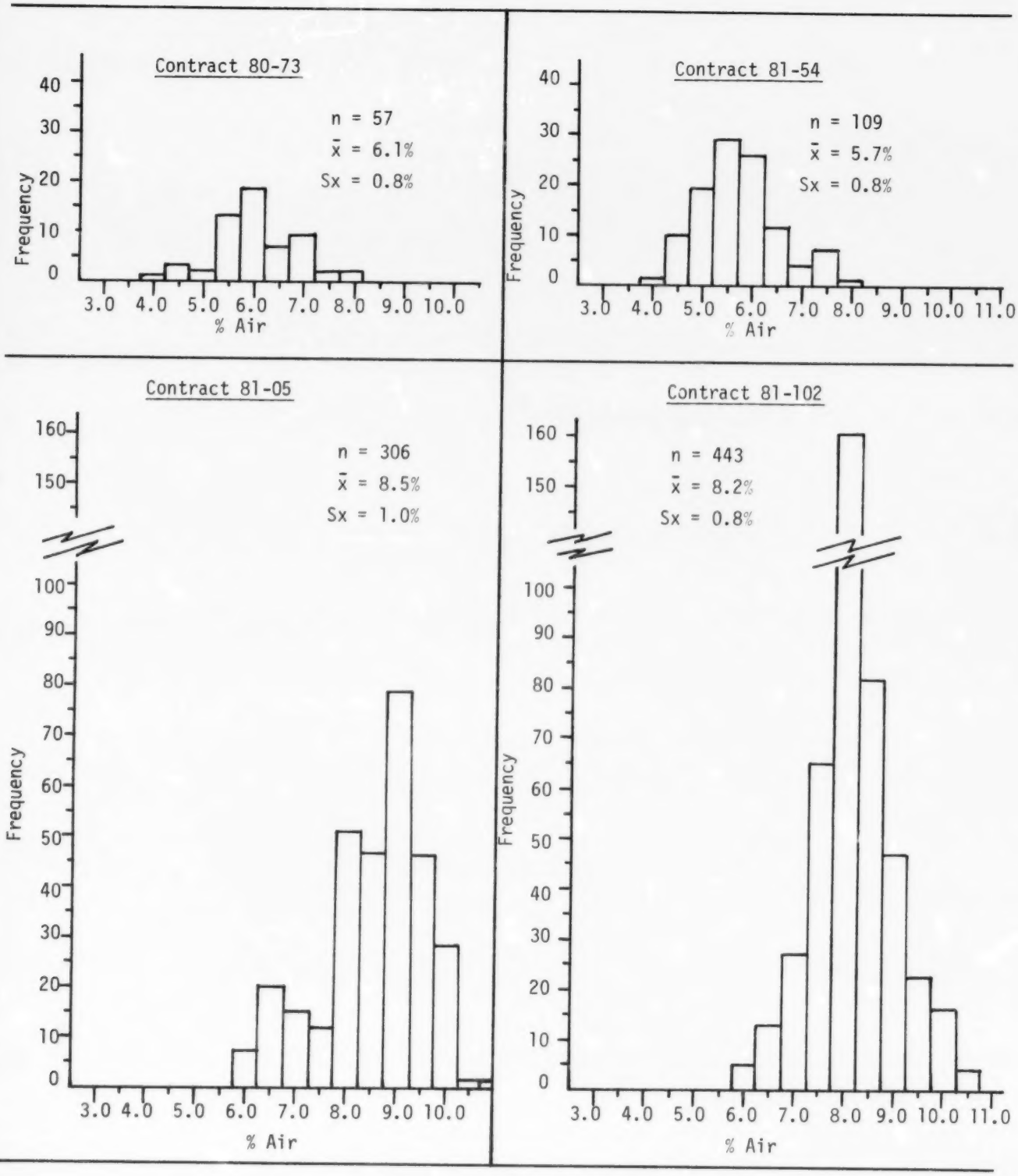


Fig. 4 (a) - Air Content Test Results, Frequency Histograms, Lean Concrete Base

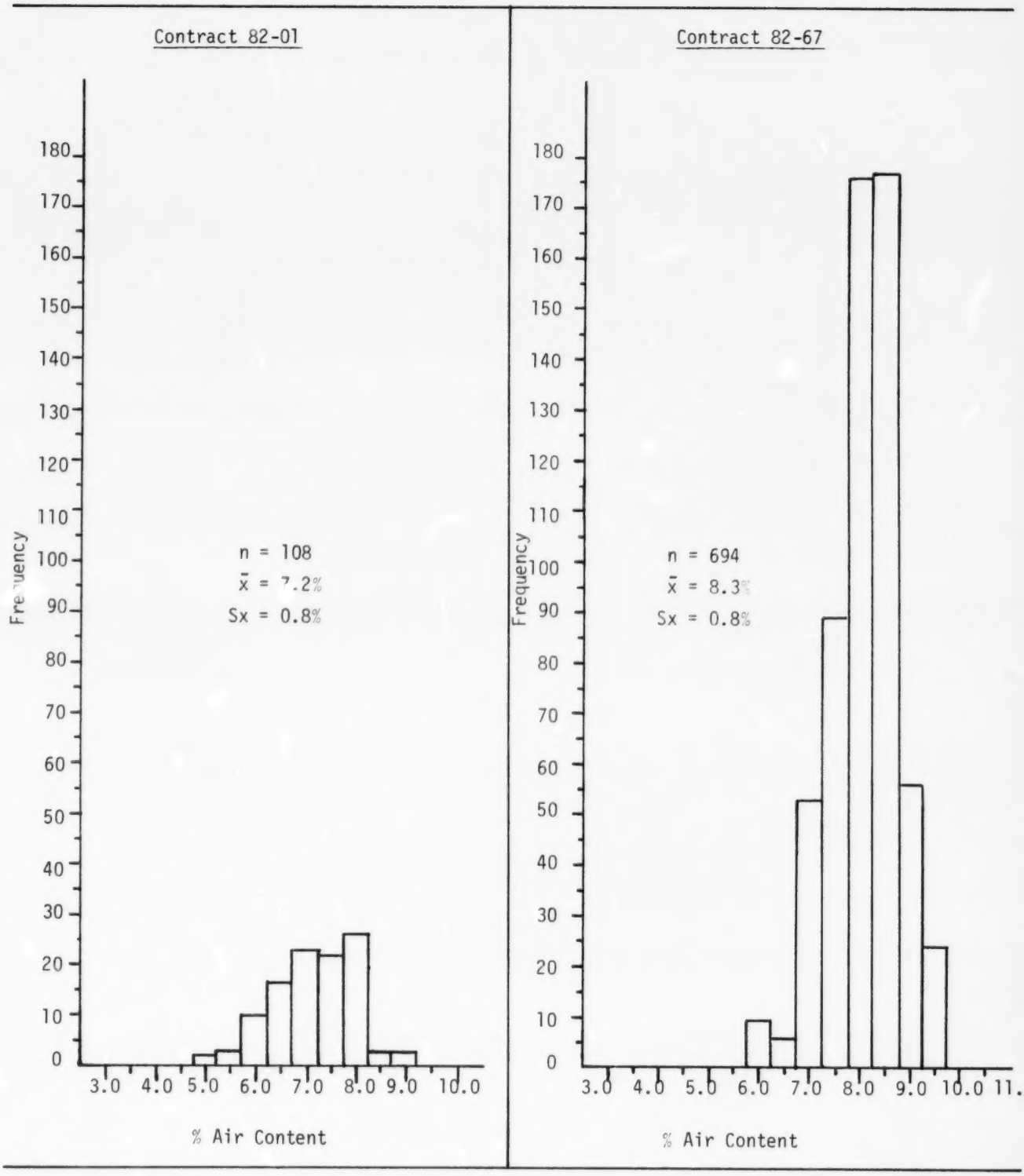


Figure 4 (b) Air Content Test Results, Frequency Histograms, Lean Concrete Base

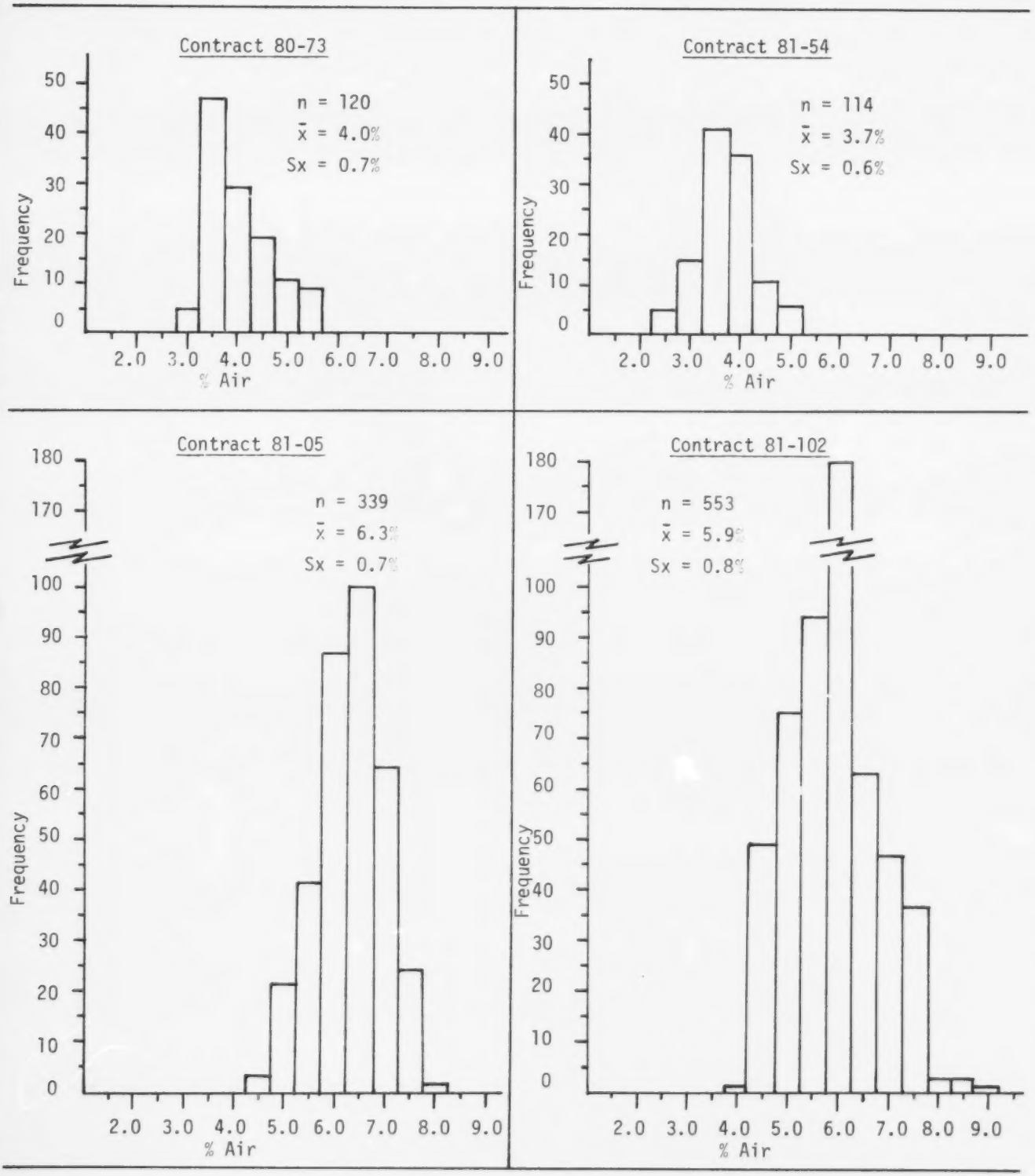


Fig. 5 (a) Air Content Test Results, Frequency Histograms, Concrete Base

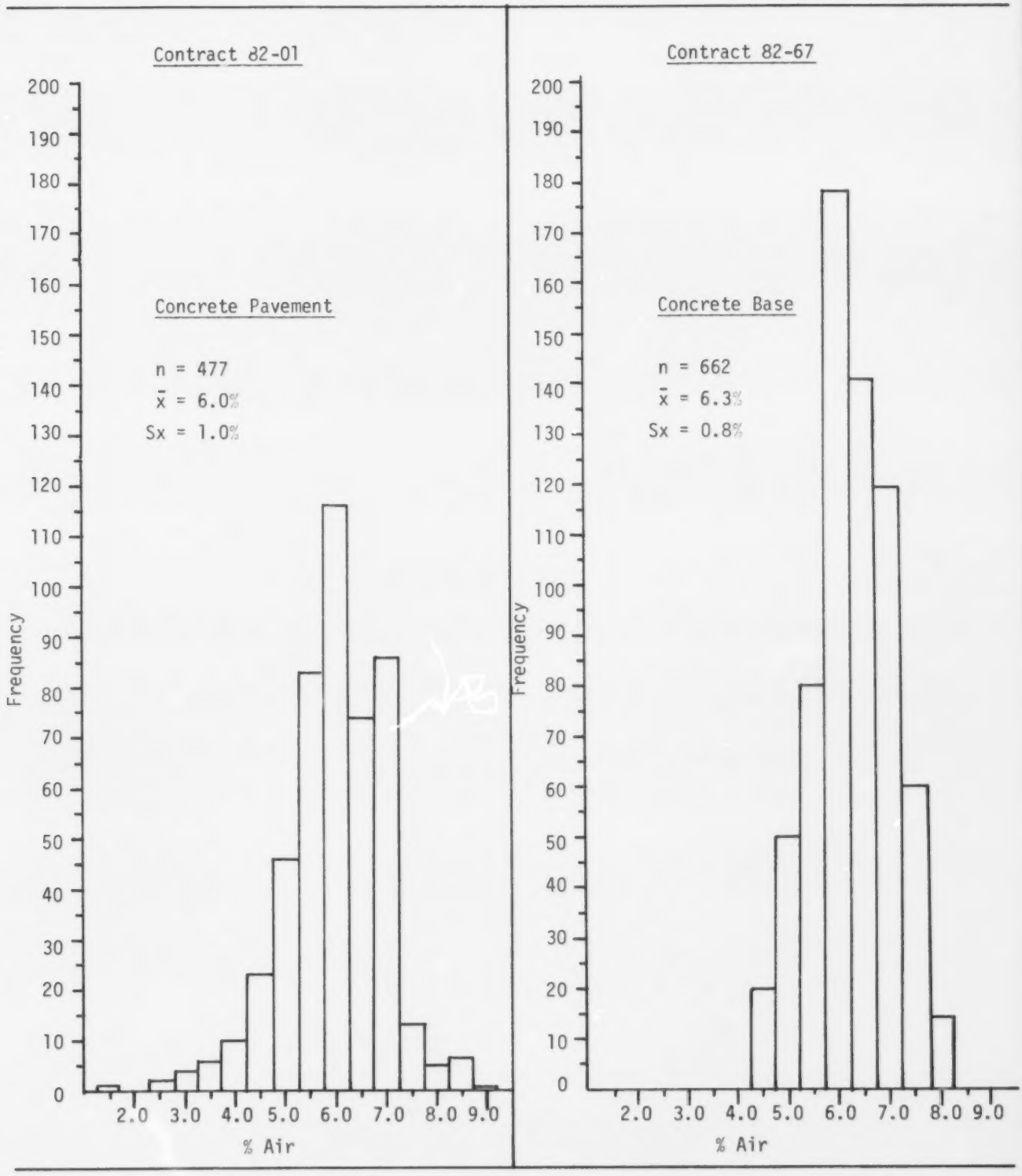


Fig. 5 (b) Air Content Test Results, Frequency Histograms, Concrete Base and Pavement

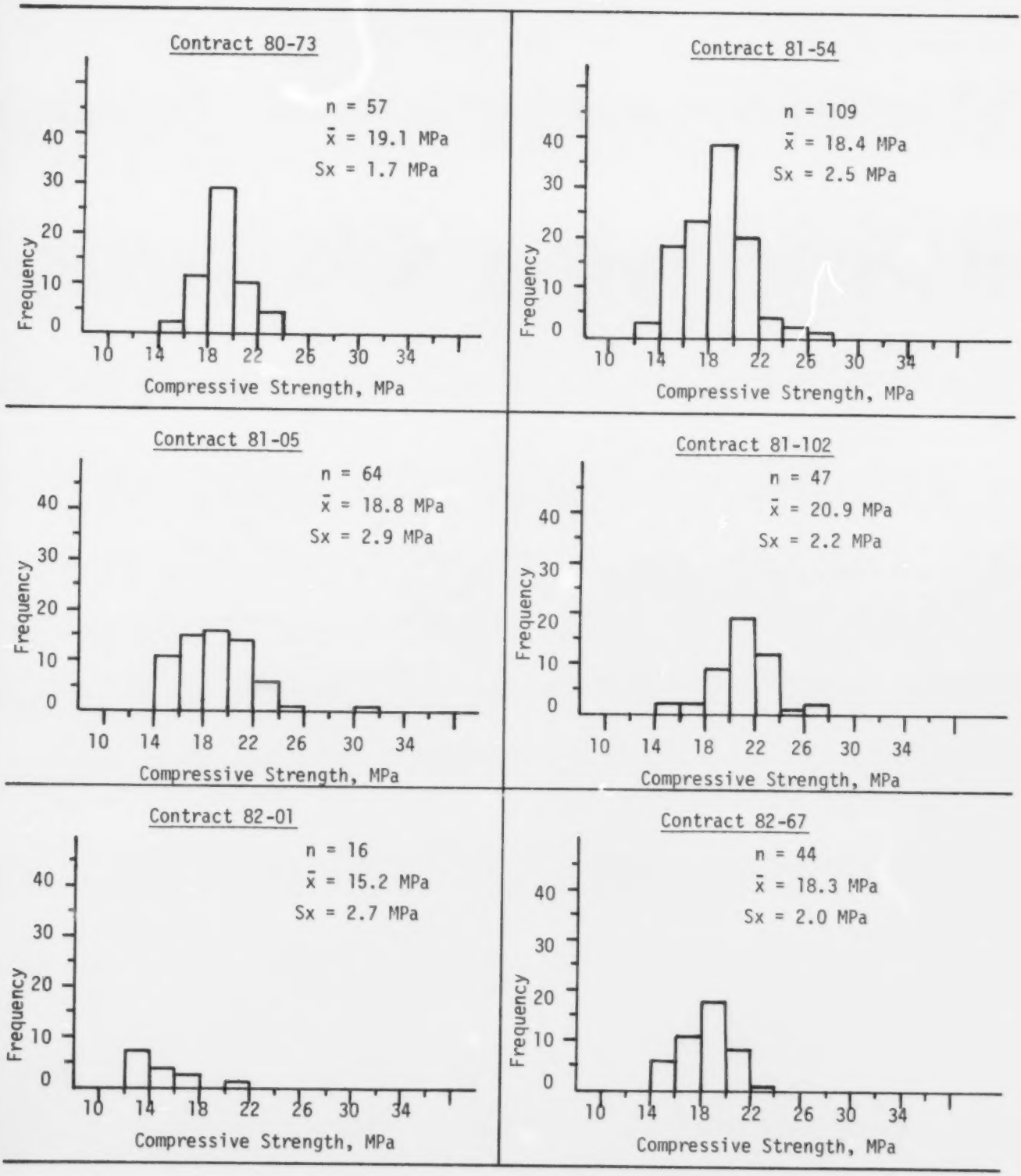


Fig. 6 Standard 28d Compressive Strength Test Results, Frequency Histograms, Lean Concrete Base

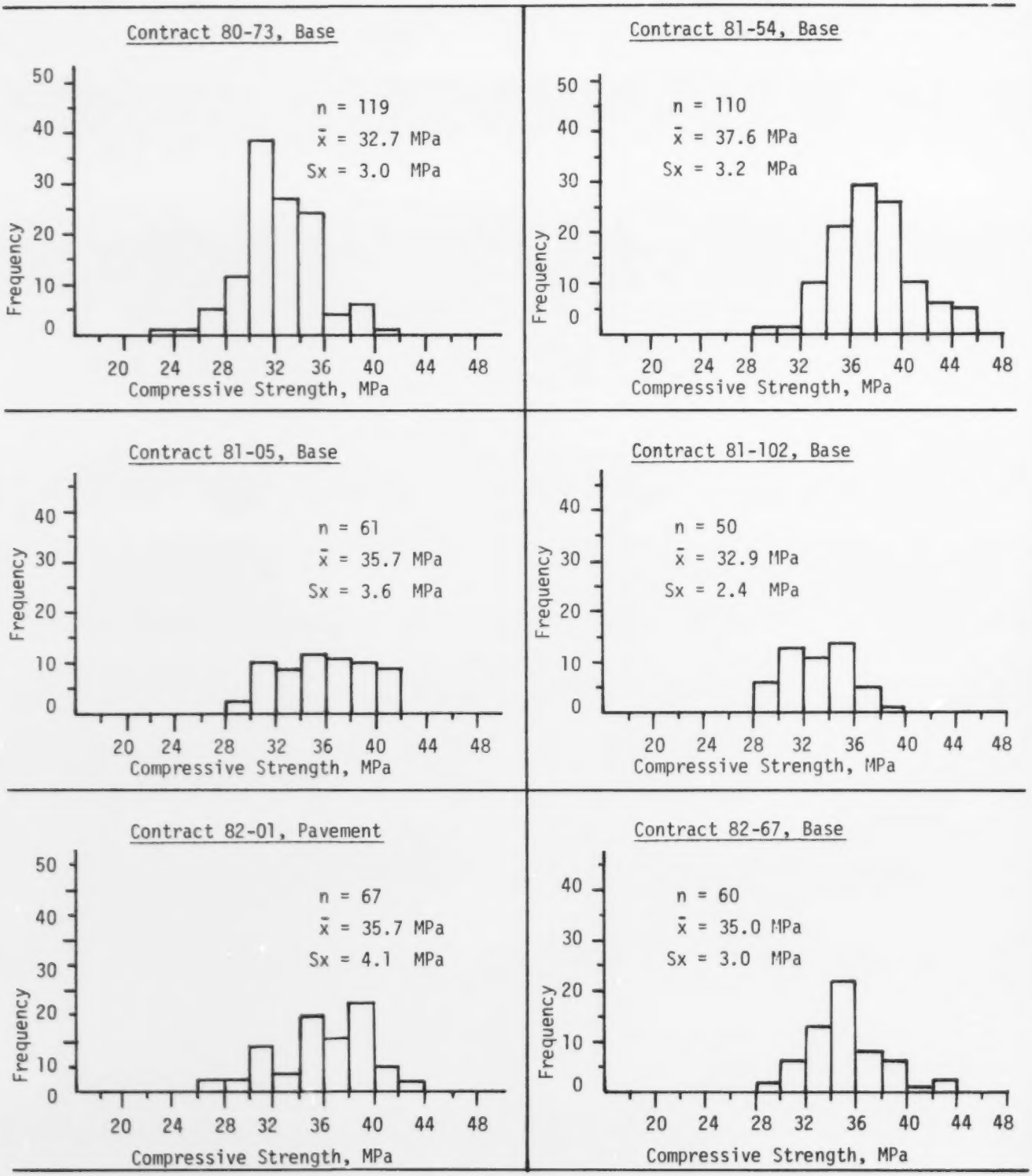


Fig. 7 - Standard 28d, Compressive Strength Test Results, Frequency Histograms, Concrete Base and Pavement

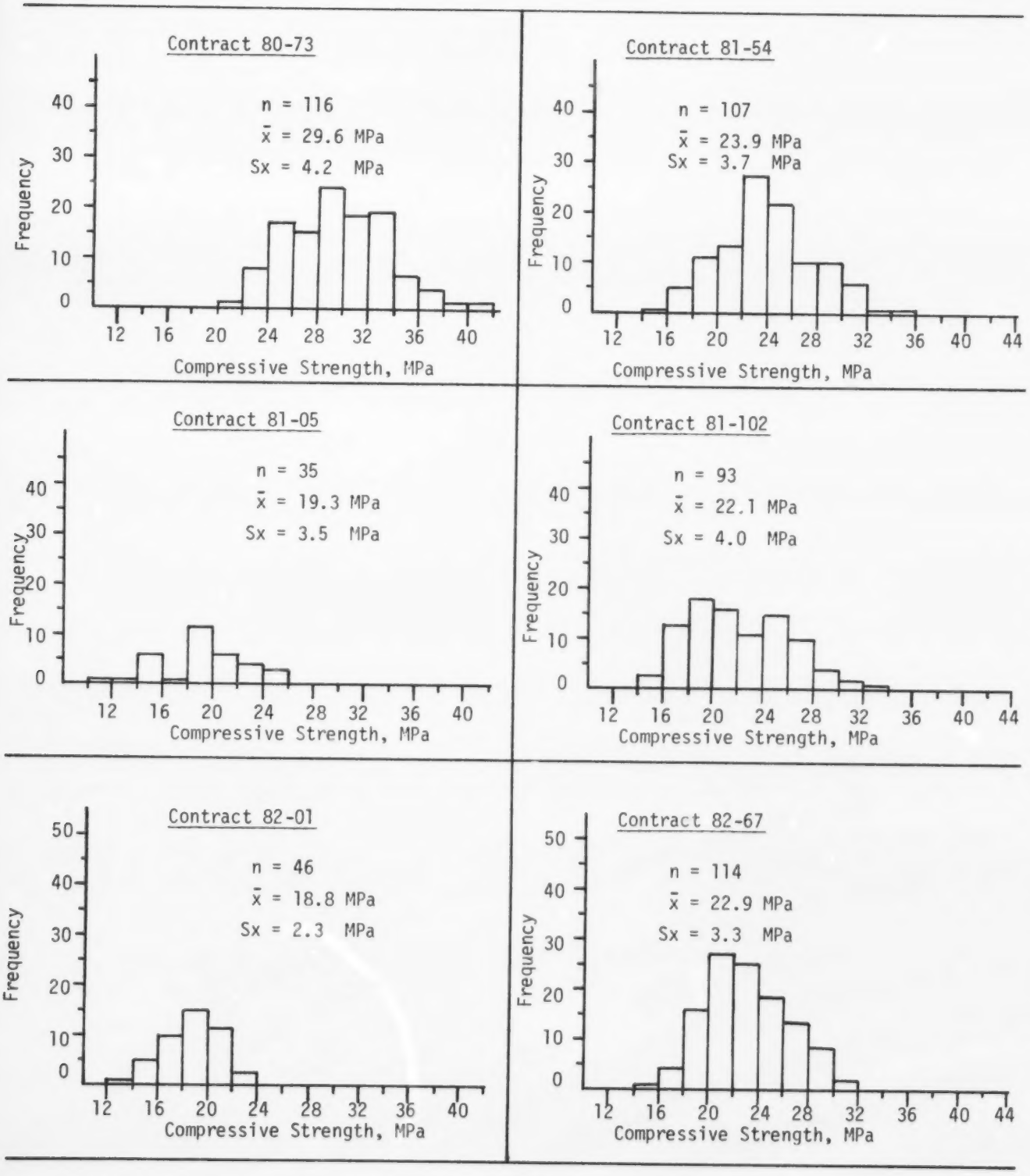


Fig. 8 - Core Compressive Strength Test Results,
Frequency Histograms, Lean Concrete Base

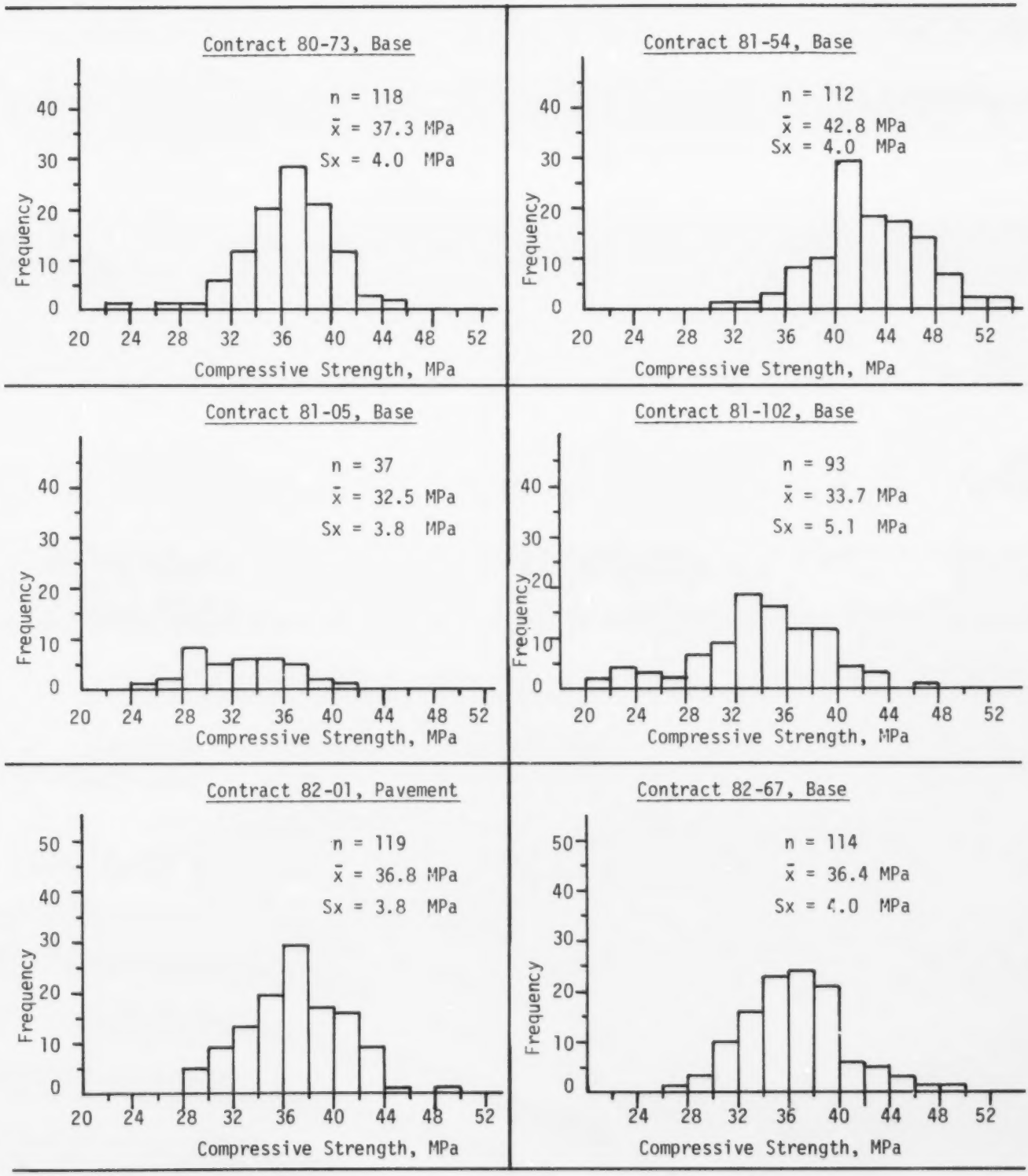


Fig. 9 - Core Compressive Strength Test Results, Frequency Histograms, Concrete Base and Pavement

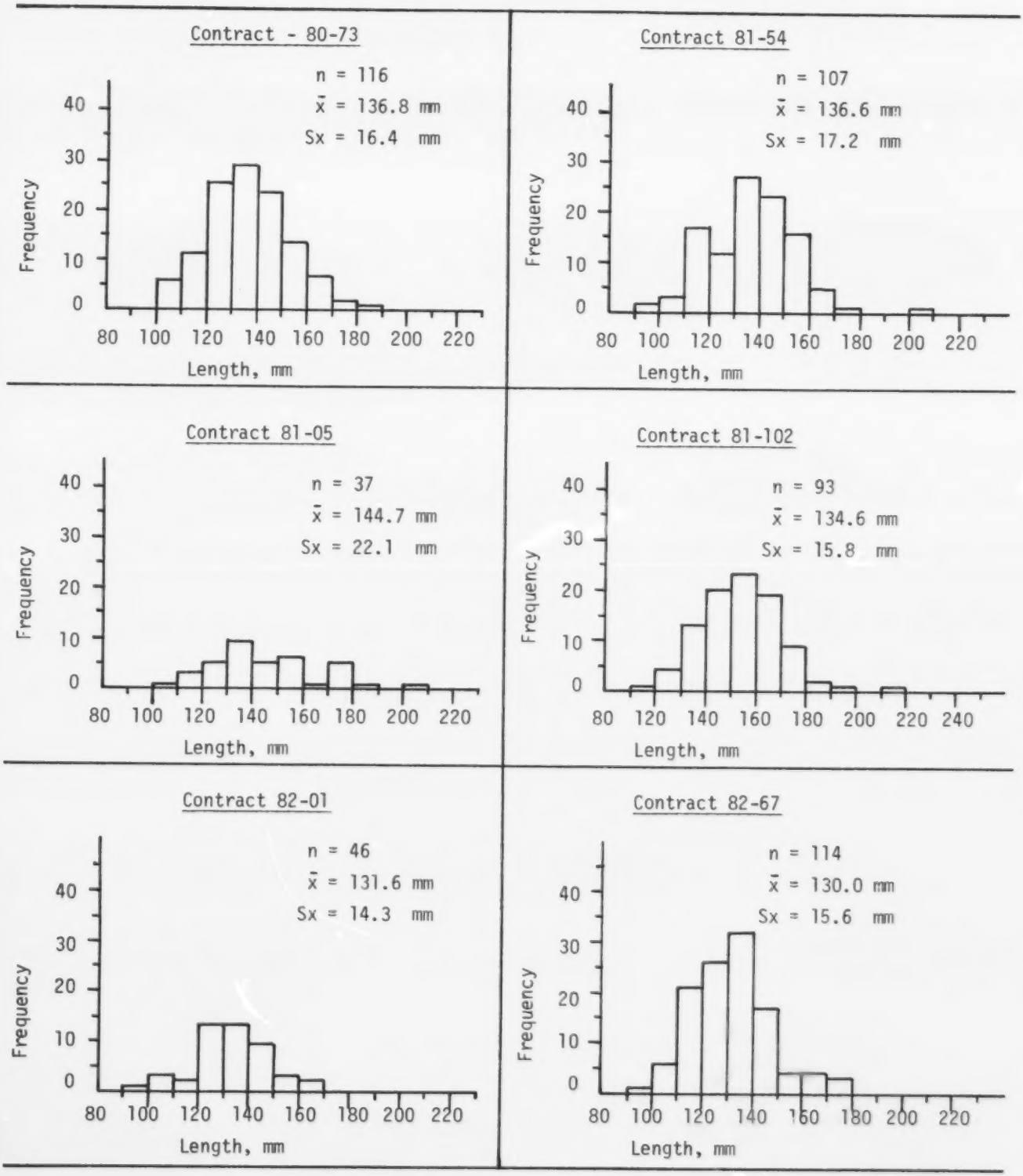


Fig. 10 Slab Thickness (core length), Frequency Histograms, Lean Concrete Bases

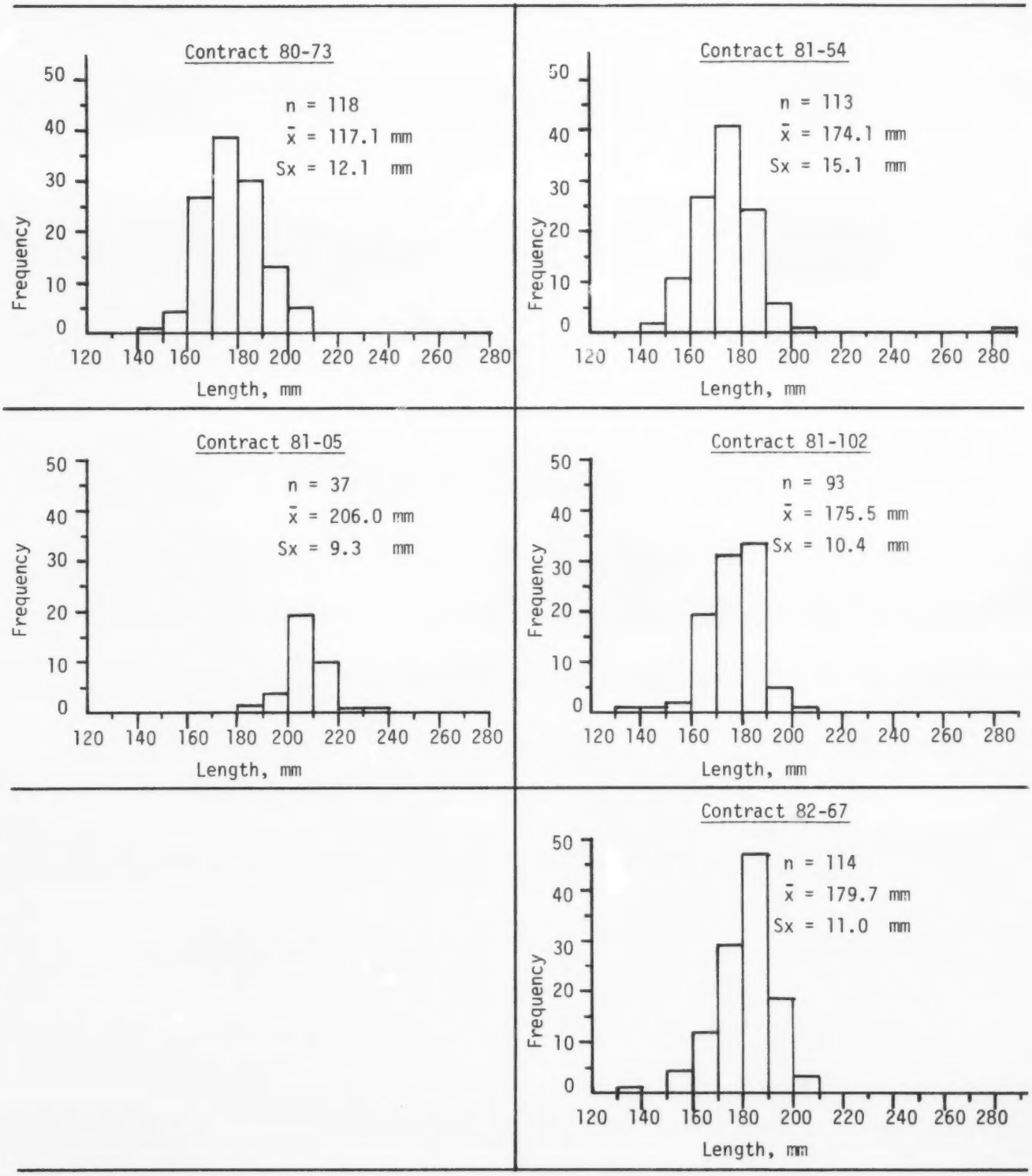
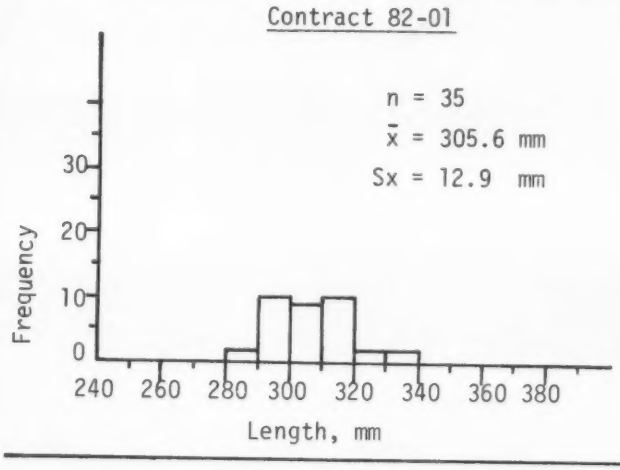
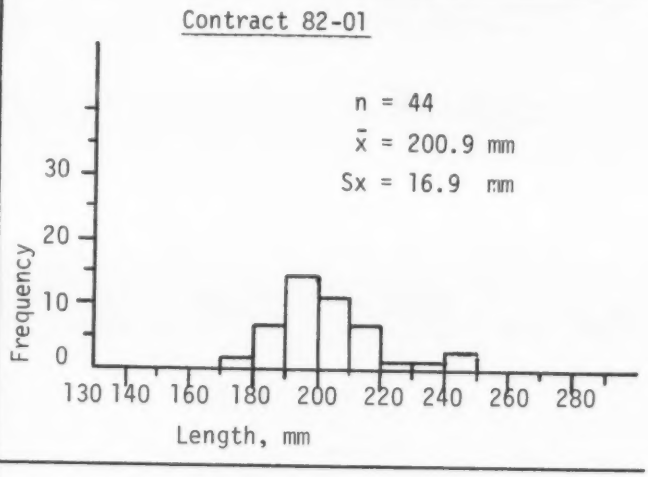


Fig. 11 - Slab Thickness (Core Length),
Frequency Histograms, Concrete Bases





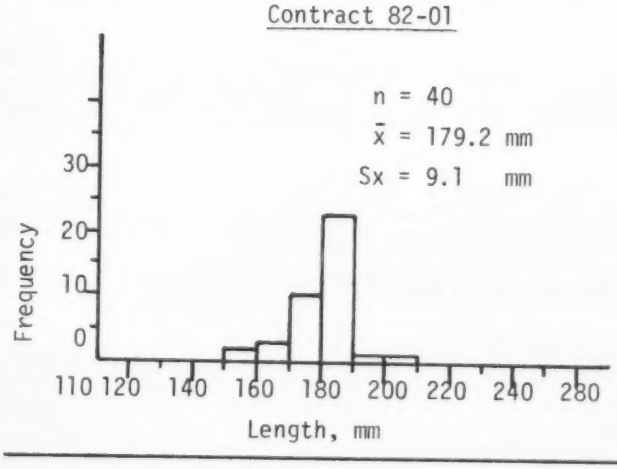


Fig. 12 - Slab Thickness (Core Length),
Frequency Histograms, Concrete Pavement

MINISTRY OF TRANSPORTATION AND COMMUNICATIONS

Specification for Obtaining and Testing of Cores From Concrete Pavement for Length and Compressive Strength

Scope

This specification covers the requirements for the obtaining, measuring for length, curing and testing of cores from concrete pavement.

Design and Location of the Concrete Pavement

The concrete pavement to be cored is part of Contract 82-01, Hwy.3 (New), from Ruthven to Essex. It consists of four sections, differing in their design and length. The four sections are as follows:

a) approximately 9700 m (6.1 miles, single lane), 305 mm (12 in.) thick concrete pavement

b) approximately 10400 m (6.5 miles, single lane), 203 mm (8 in.) thick concrete pavement

c) approximately 1500 m (0.9 mile, single lane), 330 mm (13 in.) thick concrete pavement consisting of two layers - a 127 mm (5 in.) thick lean concrete base and a 203 mm (8 in.) thick conventional concrete pavement

d) approximately 9700 m (6.1 miles, single lane), 305 mm (12 in.) thick pavement consisting of two layers - a 127 mm (5 in.) thick lean concrete and a 178 mm (7 in.) thick concrete pavement.

Size of Cores

Each core shall be 100 mm in diameter and shall be drilled through the complete depth of the concrete pavement structure (the lean concrete and pavement concrete)

Location and Number of Cores

The location of cores will be marked on the surface of the pavement by the Ministry. There will be one core from each approximate 1114 m^2 (12000 sq. ft.) of pavement, a total of approximately 104 cores. There will be approximately 35 cores from the 203 mm (8 in.) thick pavement and 69 cores from the 305 mm (12 in.) thick to 330 mm (13 in.) thick pavement structures.

Coring Age

The coring shall be carried out when the concrete pavement is 28 to 35 days old, except where the pavement is to be open to public traffic at an earlier age. In this case the cores shall be obtained before the pavement is open to the traffic. The testing laboratory will be advised by the Ministry of the date of commencement of paving operations. Thereafter it will be the responsiblity of the testing laboratory to maintain the necessary liaison with the Ministry project staff on progress of the work so that the coring operations are carried out at the specified times.

Coring

The drill bit shall be a diamond-tipped, thin-walled core drill with provision for water cooling. It shall be capable of obtaining cores of uniform diameter and perpendicular to the surface of the pavement.

Filling of Core Holes

Each core hole shall be filled with a patching mix and finished flush with the surface of the pavement. Immediately before filling, the vertical surface of each core hole must be cleaned of the "sawdust" by wire brushing. After filling each hole, all excess material shall be removed from the surface of the pavement. The strength and durability of the patching mix shall be similar to that of the base.

Identification

Each core or each part of the core, where applicable, shall be legibly marked with a durable ink immediately after its removal from the core hole. The core identification numbers will be specified by the Ministry.

Curing and Testing

Shortly after removal from the pavement, each core or each of the two parts of the core (the lean concrete base and the concrete pavement) shall be tested for length with a measuring tape to the nearest 2 mm. In the case of a two-part core, if the two-parts do not separate during the drilling operations, in most cases, they can be separated by bending the core manually over a round wooden bar. Three measurements shall be taken at equal intervals along the circumference of each part of the core. The test results shall be the average of three measurements.

If the pavement is less than 28 days old at the time of coring, each core representing the pavement and the lean concrete base, where applicable, shall be cured in accordance with CSA Test Method A23.2-3C Clause 5.3.2. until the concrete reaches an age of 28 days. The time between the coring and commencement of the curing shall not be longer than 24 hours.

All cores 28 days old or older shall be stored dry under conditions that maintain the temperature adjacent to the cores in the range of 15 - 25°C.

Each core or each part of the composite core (lean concrete and concrete pavement) shall be tested for length in accordance with ASTM C174-81, Standard Method of Measuring Length of Drilled Concrete Cores shortly after arrival in the laboratory. Prior to length measurement the base of the core shall be wire brushed, when necessary, to remove earth, granular material, etc.

Each core and each of the two parts of the composite core shall be trimmed as little as possible, capped and tested at 35-42 days in accordance with CSA Test Method A23.2-14C, Obtaining and Testing Drilled Cores for Compressive Strength Testing. If the lean concrete base is older than 35 days at the time of coring, the cores representing this concrete shall be tested not later than 5 days after the coring (The cores shall be stored at dry condition for at least 2 days before testing in compression).

Reporting Test Results

Test results shall be reported on Forms No. 1, 2 and 3 (copies enclosed). Initial field core length measurements (Form No. 1) shall be reported to the Ministry (Project Supervisor) not later than the morning of the working day following the coring operation. A copy shall be mailed to the Concrete Section to the address shown on the form.

The length test results (Form No. 2) and the compressive strength test results (Form No. 3) shall be mailed to the Concrete Section to the address shown on the form not later than 7 days after the compressive strength test.

The lean concrete base and the concrete pavement core test results shall be reported on separate copies of the forms.

Basis for Payment

Payment shall be made at the bid price per core representing the 203 mm (8 in.) thick pavement structure and at the bid price per core representing the 305 mm (12 in.) to 330 mm (13 in.) pavement structures. Such payment shall constitute full compensation for the supply of all materials, labour, equipment and for all other costs associated with the work with one exception. The exception is that the Ministry shall supply the apparatus for the measuring of core length (A.S.T.M. C174-81). The apparatus shall be returned to the Ministry after completion of the work.

Payment

The testing laboratory shall submit a monthly invoice to the Ministry for the work completed during the preceding month. Payment shall be made by the Ministry within thirty days upon receipt of the invoice.

MINISTRY OF TRANSPORTATION
AND COMMUNICATIONS
ENGINEERING MATERIALS OFFICE
CONCRETE SECTION
CENTRAL BUILDING, ROOM 111
1201 Wilson Avenue
DOWNSVIEW, ONTARIO
M3M 1J8

TELEPHONE: (416) 248-3684

FORM NO. 1

CONTRACT NO. _____

DATE CORED: _____

TESTED BY : _____

TESTING CO: _____

_____

_____

INITIAL FIELD CORE LENGTH MEASUREMENTS

LEAN CONCRETE BASE ☐ CONCRETE BASE ☐ CONCRETE PAVEMENT ☐

CORE NO.	STATION NO.	* DISTANCE FROM EDGE m	LENGTH, mm			
			a	b	c	AVERAGE

* EDGE OF DRIVING LANE

MINISTRY OF TRANSPORTATIONS AND COMMUNICATIONS
ENGINEERING MATERIALS OFFICE
CONCRETE SECTION
CENTRAL BUILDING, ROOM 111
1201 Wilson Avenue
DOWNSVIEW, ONTARIO
M3M 1J8
TELEPHONE: (416) 248-3684

FORM NO. 2

CONTRACT NO: _____

DATE CORED: _____

TESTED BY: _____

TESTING CO: _____

_____

CORE LENGTH MEASUREMENTS

LEAN CONCRETE BASE ☐ CONCRETE BASE ☐ CONCRETE PAVEMENT ☐

CORE NO.	STATION NO.	* DISTANCE FROM EDGE m	LENGTH, mm									
			a	b	c	d	e	f	g	h	i	AVERAGE

* EDGE OF DRIVING LANE

MINISTRY OF TRANSPORTATIONS AND COMMUNICATIONS
ENGINEERING MATERIALS OFFICE
CONCRETE SECTION
CENTRAL BUILDING, ROOM 111
1201 Wilson Avenue,
DOWNSVIEW, Ontario
M3M 1J8

TELEPHONE: (416) 248-3684

FORM NO. 3

CONTRACT NO. _____

TESTING CO: _____

_____

CORE COMPRESSIVE STRENGTH

LEAN CONCRETE BASE ☐ CONCRETE BASE ☐ CONCRETE PAVEMENT ☐

CORE NUMBER	STATION NO.	* DISTANCE FROM EDGE, m	DATE CORED	DATE TESTED	AGE OF CONCRETE, DAYS	DIAMETER mm (D)	CAPPED LENGTH mm (L)	$\frac{L}{D}$	CORRECTION FACTOR	STRENGTH MPa	CORRECTED STRENGTH MPa

* DRIVING LANE

Appendix B

SPECIAL PROVISION NO. 120.04
ACCEPTANCE OF LEAN CONCRETE BASE
CONCRETE BASE AND CONCRETE PAVEMENT

Concrete

Subsection 350.05.01 of Form 350 is deleted and replaced by the following:

Concrete materials shall comply with form 350 requirements except that:

a) 19.0 nominal maximum size aggregate according to Table II of Form 1002 may be used. Where 19.0 mm nominal maximum size aggregate is used, Type WN or SN admixture shall be added to the concrete.

b) Aggregate for lean concrete base shall be Granular A meeting the requirements of Form 1010 except that a maximum of 12% passing the 75 μm sieve shall be permitted.

c) Lean concrete mix shall have a minimum cement content of 175kg/m^3. Type WN or SN admixture shall be added to the concrete.

d) The slump and air content shall be determined on samples obtained from the grade in front of the paver and they shall be as follows:

	Slump, mm	Air Content, %
Lean concrete base	55±45	8.5±2.5
Concrete base or pavement	55±45	6.0±2.0*
		6.5±2.5**

*when 37.5 mm nominal maximum size aggregate is used
**when 19.0 mm nominal maximum size aggregate is used

e) The strength tests and requirements in Subsection 1350.08.02 are deleted and replaced with the requirements stated in this Special Provision.

Thickness Tolerance

Subsections 350.07.04.06, 350.07.11.04 and 350.07.12.04 of Form 350 are deleted and replaced with the requirements stated in this Special Provision.

Surface Tolerance

Subsection 350.07.04.05 of Form 350 is deleted and replaced with the requirements for Profile Index stated in this Special Provision.

Acceptance Criteria

General. Lean concrete base, concrete base and concrete pavement will be accepted by lots on the basis of core compressive strength and slab thickness. In addition, concrete pavement will be accepted on the basis of profile index. The core compressive strength, slab thickness and profile index shall be determined in accordance with the methods described in the "Method of Test of Lean Concrete Base, Concrete Base and Concrete Pavement for Compliance with the Requirements of Special Provision No. 120.04."

Lot Size. The slab shall be divided into lots. Each lot shall consist of approximately 4000 m^2 of lean conrete base, concrete base or concrete pavement and it shall be divided into four sublots of equal size.

Location of Cores. The location of cores in each sublot shall be selected using a table of random numbers.

Compressive Strength. Lean concrete base lot will be accepted at 100% of the contract unit price when its mean core compressive strength is 10.0 MPa or higher and at reduced payment when the strength is lower than 10.0 MPa but at least 6.0 MPa. Concrete base or concrete pavement lot will be accepted at 100% of the contract unit price when it's mean core compressive strength is 25.0 MPa or higher and at reduced payment when the strength is lower than 25.0 MPa but at least 17.5 MPa. Where the strength of lean concrete base lot is lower than 6.0 MPa and where the strength of concrete base or concrete pavement lot is lower than 17.5 MPa, the lot shall be removed and replaced by the contractor at his expense.

The cores shall be tested in compression when the concrete is 35 to 42 days old.

The mean core compressive strength shall be calculated from the following formula.

$$\bar{X} = \frac{X_1 + X_2 + X_3 + X_4}{4}$$

where $\bar{X}$ is the mean core compressive strength

X_1, X_2, X_3, X_4 are the compressive strength obtained on cores from sublot 1,2,3 and 4, respectively.

When the strength does not meet the acceptance criteria and additional coring of the lot is agreed upon, one additional core shall be taken from each sublot. In this case, the mean core compressive strength shall be calculated using the following formula.

$$X = \frac{X_1 + X_2 + X_3 + X_4 + X_{1a} + X_{2a} + X_{3a} + X_{4a}}{8}$$

where X_1, X_2, X_3, X_4 are the original compressive strengths obtained on cores from sublot 1, 2, 3, and 4, respectively.

X_{1a}, X_{2a}, X_{3a}, X_{4a} are the compressive strengths obtained on the additional cores from sublot 1, 2, 3, and 4, respectively.

If the additional coring is at request of the contractor, the cost of the coring and testing of the additional cores shall be paid by the contractor if the mean strength (n=8) is below the requirement for 100% payment.

Slab Thickness. Lean concrete base, concrete base or concrete pavement lot will be accepted at 100% of the contract unit price when the deficiency in concrete thickness is not greater than 3.0 mm. Where the deficiency is greater than 30.0 mm, the lot shall be removed and replaced by the contractor at his expense. The deficiency (D) in the average slab thickness (core length) shall be calculated as follows:

$D = \bar{X}$ - specified thickness

where $\bar{X} = \frac{X_1 + X_2 + X_3 + X_4}{4}$

$\bar{X}$ to be rounded off to the nearest 0.1 mm

X_1, X_2, X_3, X_4 are lengths of cores from sublot 1, 2, 3 and 4, respectively.

Where there is a situation where the lean concrete base is deficient in thickness by more than 3.0 mm and the concrete base or concrete pavement above the lean concrete is thicker than specified by more than 5.0 mm, the excess thickness (actual thickness - specified thickness plus 5.0 mm) shall be credited to the length of the lean concrete base core to reduce the deficiency. This correction shall not apply to the situations where the deficiency is in the concrete base or pavement.

Profile Index. Profilograph measurements shall be obtained separately for each lot between 7 and 21 days after placing the pavement. They shall be taken in the wheel paths of the pavement in the direction of paving and only with the profilograph operating in the forward direction. The wheel paths shall be taken as 900 mm inside all lane edges.

Concrete pavement lot will be accepted at 100% of the contract unit price when the profile index is 200 mm/km or smaller. Where the profile index is greater than 200 mm/km but not greater than 600 mm/km, the lot will be accepted at reduced payment. Where the profile index is greater than 600 mm/km, the contractor shall correct the pavement surface by grinding. The contractor shall remove all bumps greater than 12 mm by grinding.

Acceptance shall be based on the final profile index (after grinding).

Removal of Slabs

If the mean core compressive strength and/or the deficiency in the thickness of the slab dictates removal or replacement of the lot, additonal cores shall be taken to establish the extent of the deficient area. The cores shall be taken along the longitudinal axis of the lane at 3 m intervals in both directions starting 3 m from the location of the original core.

The area to be removed shall be bounded by the nearest contraction joint and the longitudinal joint or pavement edge outside the deficient area so that there shall be no additional joints where the transverse joint spacing is less than 6.0 m. Where the joint spacing is more than 6.0 m, the Ministry may allow the contractor to make a construction joint to reduce the length of the slab to be removed.

Basis of Payment

Measurement for payment and payment will be according to Form 350 except that, where work does not meet the quality requirements stated in this special provision, adjustments for each lot will be made in accordance with the following.

Table A. Adjustment of Contract Price, Compressive Strength

Mean Core Compressive Strength, MPa				Percent of Contract Price to Be Paid
Lean Concrete Base		Concrete Base or Pavement		
n=4	n=8	n=4	n=8	
≥10.0	≥11.6	≥25.0	≥26.8	100
9.9-9.0	11.5-10.6	24.9-23.5	26.7-25.3	99
8.9-8.0	10.5- 9.6	23.4-22.0	25.2-23.8	97
7.9-7.0	9.5- 8.6	21.9-20.0	23.7-21.8	94
6.9-6.0	8.5- 7.6	19.9-17.5	21.7-19.3	90
<6.0	<7.6	<17.5	<19.3	Remove and Replace slab

Table B. Adjustment of Contract Price, Slab Thickness

Deficiency in the Average Length of 4 cores	Percent of Contract Price to Be Paid
0-3.0	100
2.9-6.0	99
6.1-9.0	97
9.1-13.5	94
13.6-18.0	89
18.1-22.5	83
22.6-30.0	75
30.1 or more	Remove and replace

Table C. Adjustment of Contract Price, Profile Index

Profle Index, mm/km	Percent of Contract Price to be Paid
≤200	100
201-275	99
276-350	97
351-450	94
451-600	90

Multiple Deficiencies. If a lot fails to qualify for a full payment due to more than one deficiency, the payment shall be made in accordance with the following formula.

$P = A + B - 100$ for lean concrete base and concrete base

$P = A + B + C - 200$ for concrete pavement

where P is the final payment, % of contract price.

A is percent payment dictated by the deficiency in core compressive strength.

B is percent payment dictated by the slab thickness deficiency.

C is percent payment dictated by the profile index.

METHOD OF TEST OF LEAN CONCRETE BASE, CONCRETE BASE AND CONCRETE PAVEMENT FOR COMPLIANCE WITH THE REQUIREMENTS OF SPECIAL PROVISION NO. 120.04.

Scope

This method of test covers the procedures for the testing of lean concrete base, concrete base and concrete pavement slabs for compressive strength and thickness and concrete pavement for profile index. The test results are used for the determination of compliance of the lean concrete base, concrete base and concrete pavement with the requirements of Special Provision No. 120.04.

Compressive strength and slab thickness is determined on cores obtained from each sublot, and profile index is determined by using the California Type Profilograph.

Coring, Curing and Testing

Size of Cores. Each core shall be 100 mm in diameter and shall be drilled through the complete depth of the lean concrete base, concrete base, concrete pavement or composite slab structure.

Location of Cores. The location of the core in each sublot will be determined using a table of random numbers. No core shall be taken within 250 mm of any joint or edge of the slab.

Coring Age. The coring shall be carried out when the top concrete slab is 28 to 35 days old except where the pavement is to be open to public traffic at an earlier age or where a hot mix overlay is to be placed prior to 35 days. In these cases the cores shall be obtained before the opening of the pavement to traffic or before the hot mix is placed.

Curing and Testing. If the core represents a composite structure, e.g. lean concrete base and concrete base or pavement, and it does not separate during the drilling, it can be separated, in most cases, by bending it over a round wooden bar. If the concrete is less than 28 days old at the time of coring, each core representing the concrete shall be cured in accordance with C.S.A. Test Method A23.2-3C Clause 5.3.2 until the concrete reaches an age of 28 days. The time between the coring and commencement of the curing shall not be longer than 24 hours.

Each core 28 days old or older shall be stored dry under conditions that maintain the temperature adjacent to the cores in the range of 15 - 25°C. Each core or each part of the composite core shall be tested for length in accordance with A.S.T.M. C174-81, Standard Method of Measuring Length of Drilled Concrete Cores, shortly after arrival in the laboratory. Prior to length measurement, the base of the core shall be wire brushed where necessary to remove earth, granular materials, etc.

Each core shall be tested at 35 - 42 days for compressive strength in accordance with C.S.A. Test Method A23.2-14C, Obtaining and Testing Drilled Cores for Compressive Strength Testing. If the lean concrete base is older than 35 days at the time of coring, the cores representing this concrete shall be tested not later than 5 days after the coring. Such cores shall be stored at dry condition for at least 2 days before testing in compression.

Operation of California Profilograph and Evaluation of Profiles

This method describes the operation of the California Type Profilograph, the procedure used for determining the Profile Index from profile traces of pavements made with the Profilograph, and the procedure used to locate individual bumps in excess of 0.5 inch on these traces. The profilograph is available only in Imperial Units, thus all the measurements are in these units. The profile index is calculated in inch/mile and converted to mm/km.

Profilograph. The California Type Profilograph consists of a frame twenty-five feet in length supported on multiple wheels at either end to establish a datum for what is, in effect, a rolling straightedge. At the mid-point of the frame is located a "Profile Wheel" with linkage to a recorder (Figure 1).

As the device is moved over a pavement, deviations of the profile wheel from the datum plane established by the frame are shown on the recorder. The trace thus formed is referred to as the "Profile". The continuous paper chart is referred to as the "Profile Trace". The profile trace is recorded on a scale of one-inch equal to twenty-five feet (1"=25') longitudinally and one-inch equal to one-inch (1"=1"), or full scale, vertically.

Calibration. Calibration of the Profilograph shall be checked prior to its initial use on each Contract. The horizontal scale shall be checked by running a known distance and scaling the result on the profile trace. If the horizontal scale is inaccurate by more than 2%, the profile wheel shall be adjusted, if

possible, or changed to one of a proper diameter prior to initial use. The vertical scale shall be checked by putting a board of known thickness under the profile wheel and scaling the results on the profile trace. If the vertical scale is in error, the cause of the incorrect height shall be determined and corrected prior to use.

Operation. All objects on the surface of the pavement including mortar balls shall be removed prior to profilographing.

The profilograph measurements shall be obtained separately for each lot (4000 m^2 of paving).

Each profilograph measurement shall be stopped approximately every 200 feet. With the profilograph stopped, raise the recording wheel approximately one-inch to mark this location on the graph. Then write the station on the graph adjacent to this mark. Repeat this procedure every 200 feet. For each adjacent wheelpath the same procedure shall be followed except that the stationing need only be written on the initial wheelpath. This procedure assures that any area on the profilograph trace can readily by located on the pavement.

The profilograph shall be operated in the wheelpaths of the mainline pavement. The wheelpaths shall be longitudinal lines located parallel to the centreline of pavement and three feet measured transversely, inside all lane edges. A measuring guide can be placed on the profilograph, the pavement wheelpaths can be continuously marked or an alternative method can be used.

The profilograph measurements shall be obtained in the direction of paving. All wheelpath measurements shall be obtained in the same direction.

The measurements shall be obtained with the profilograph operating in the forward direction.

The profilograph shall be operated at a speed no greater than a walk, so as to eliminate as much bounce as possible. Too high a speed will result in a profile trace that is difficult to evaluate. The air pressure in the profile wheel shall be adjusted to further minimize the effect of wheel bounce.

Equipment. To determine the preliminary profile index, use a plastic scale 1.70 inches wide and 10.0 inches long representing a pavement length of 250 feet at a scale of 1" = 25'. Near the centre of the scale is an opaque band 0.2 inch wide

extending the entire length of 10.0 inches. On either side of this band are scribed lines 0.1 inch apart, parallel to the opaque band. These lines serve as a convenient scale to measure deviations or excursions of the trace above or below the blanking band (Figure 2).

Method of Counting. Place the plastic scale over the profile in such a way as to "blank out" as much of the profile as possible. When this is done, deviations above and below the blanking band usually will be approximately balanced (Figure 2).

The profile trace shall be reduced in the direction of paving. When the plastic scale is in position precisely mark the top and bottom at each end. This allows the scale to be repositioned exactly if future reference is required.

Starting at the right end of the scale, measure and record the height of all the deviations appearing both above and below the blanking band, measuring each deviation in tenths of an inch to the nearest 0.05 inch (half a tenth). Short portions of the profile trace may be visible outside the blanking band but unless they project 0.03 inch or more and extend longitudinally for one and one-half feet (0.06 inch on the trace) or more, they shall not be included in the count. Obtain the sum of these deviations and write the total near the centre of the profile trace. To check the addition, recompute the total, adding in the opposite direction, and if the total checks circle the original number.

Repeat this procedure for all remaining wheelpaths. Next, add the circled totals and divide by the number of wheelpaths to obtain an average for that 250' section.

After deviations occurring in the first 250' section are averaged, slide the scale to the left and proceed with the counting in the same manner. The last section counted may or may not be an even 250' section. If not, its length should be scaled to determine its length in miles. An example follows:

two lane pavement placed in one pass of the paving track
Lot #1, 4000 m^2 (43057 $ft.^2$) Length 546.8 m (1794 ft.).

Station No.	Section Length, feet	Profile Counts, tenth of an inch					Profile Index
		Wheel Path No.				Average	
		1	2	3	4		
00 + 00	250	3.5	4.5	3.5	11.5	5.8	12.2
02 + 50	250	0	1.0	3.5	4.5	2.3	4.9
05 + 00	250	0.5	1.0	1.5	1.5	1.1	2.3
07 + 50	250	0	0.5	1.0	0	0.4	0.8
10 + 00	250	2.5	5.5	6.0	11.0	6.3	13.3
12 + 50	250	6.5	11.5	18.0	20.5	14.1	29.8
15 + 00	250	1.0	2.0	1.0	2.5		
15 + 44	44 | 294 *	0.5	1.0	0.5	1.5	2.5	5.3
Total for the entire Lot						32.5	9.6

* when the length of the last section is less than 125 ft., combine it with the preceding section as shown

$$\text{Profile Index (inch/mile)} = \frac{5280}{\text{Length of section (or lot), ft.}} \times \text{total count in inches}$$

$$\text{Profile Index for the lot} = \frac{5280}{1794} \times 3.25 = 9.6 \text{ inch/mile}$$

$$\text{Profile Index for the lot} = 9.6 \times 15.78 = 151 \text{ mm/km}$$

Determination of Bumps in Excess of 0.5 in. Use a plastic template having a line one-inch long scribed on one face with a small hole or scribed mark at either end, and a slot 0.5 inch from and parallel to the scribed line. (The one-inch line corresponds to a horizontal distance of 25 feet on the horizontal scale of the profile trace, Figure 3).

At each prominent peak or high point on the profile trace, place the template so that the small holes or scribe marks at each end of the scribed line intersect the profile trace to form a chord across the base of the peak or indicated bump. The line on the template need not be horizontal. With a sharp pencil draw a line using the narrow slot in the template as a guide. Any portion of the trace extending above this line will indicate the approximate length and height of the deviation in excess of 0.5 inch.

There may be instances where the distance between easily recognizable low points is less than one-inch (25 feet). In such cases a shorter chord length shall be used in making the scribed line on the template tangent to the trace at the low points. It is the intent, however, of this requirement that the baseline for measuring the height of bumps will be as nearly 25 feet (one-inch) as possible, but in no case to exceed this value. When the distance between prominent low points is greater than 25 feet (one-inch) make the ends of the scribed line intersect the profile trace when the template is in a nearly horizontal position. A few examples of the procedure are shown in the lower portion of Figure 3.

All bump locations shall be tabulated by survey station and wheel path for each day's paving.

Determination of the Final Profile Index. Any section of pavement which has been corrected due to the presence of surface irregularities is to be remeasured with the Profilograph after corrections have been completed. This remeasurement is to begin and end at a full or half survey station and extend a minimum distance of 50 feet on each side of the corrected section.

The results of the corrective action on each section containing surface irregularities shall be checked to ensure specification conformance.

After all bumps have been satisfactorily corrected the Final Profile Index shall be determined for each lot. The profile traces obtained from any section of corrected (due to the presence of surface irregularities) and remeasured pavement shall be superimposed on the preliminary, profile traces. The Final Profile Index is then determined for each lot from the combination of both the preliminary profile traces and the superimposed corrected sections. If no corrective action in any section is required due to the absence of surface irregularities in that section, the preliminary profile index shall become the Final Profile Index for that section.

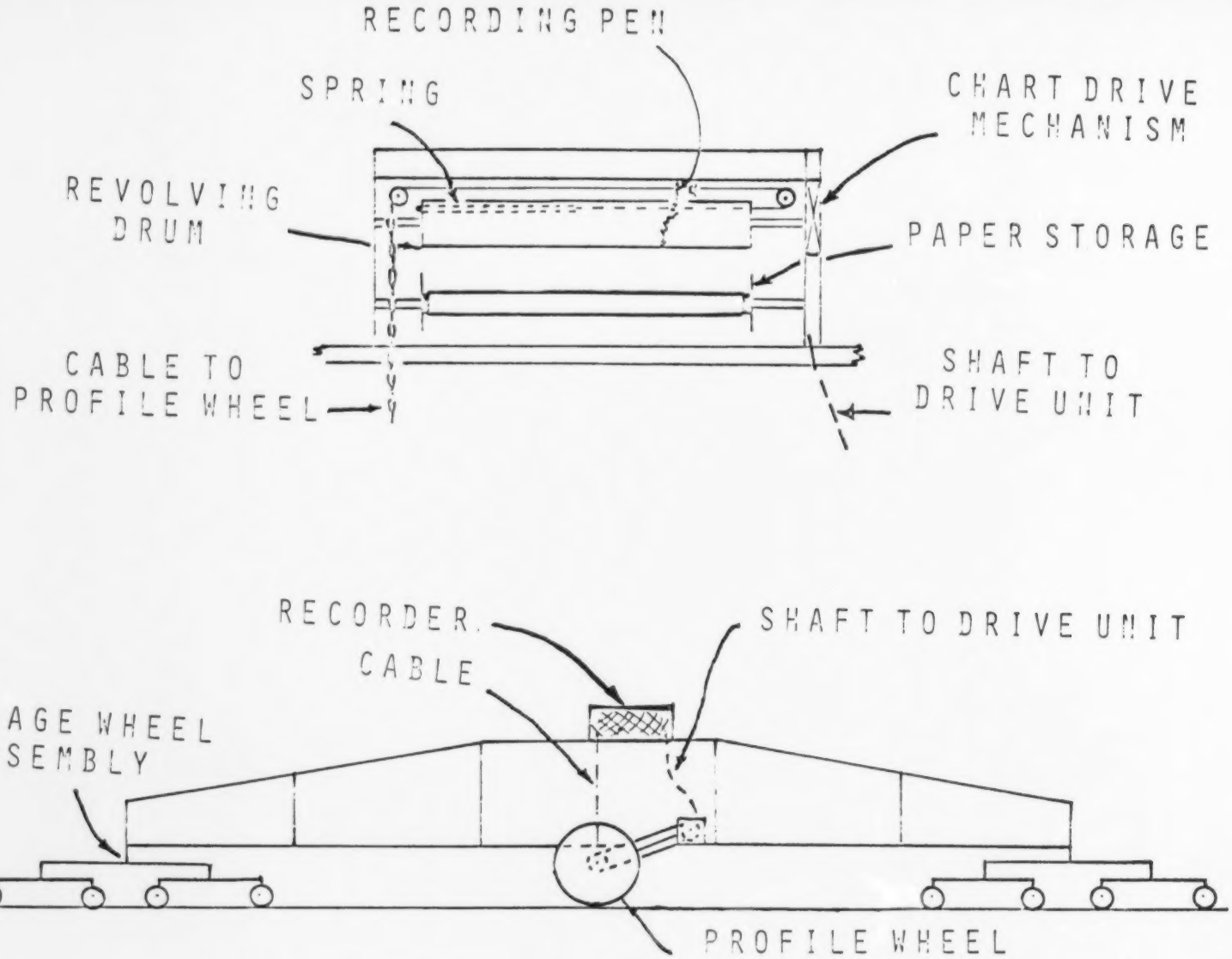


FIG. 1 PROFILOGRAPH

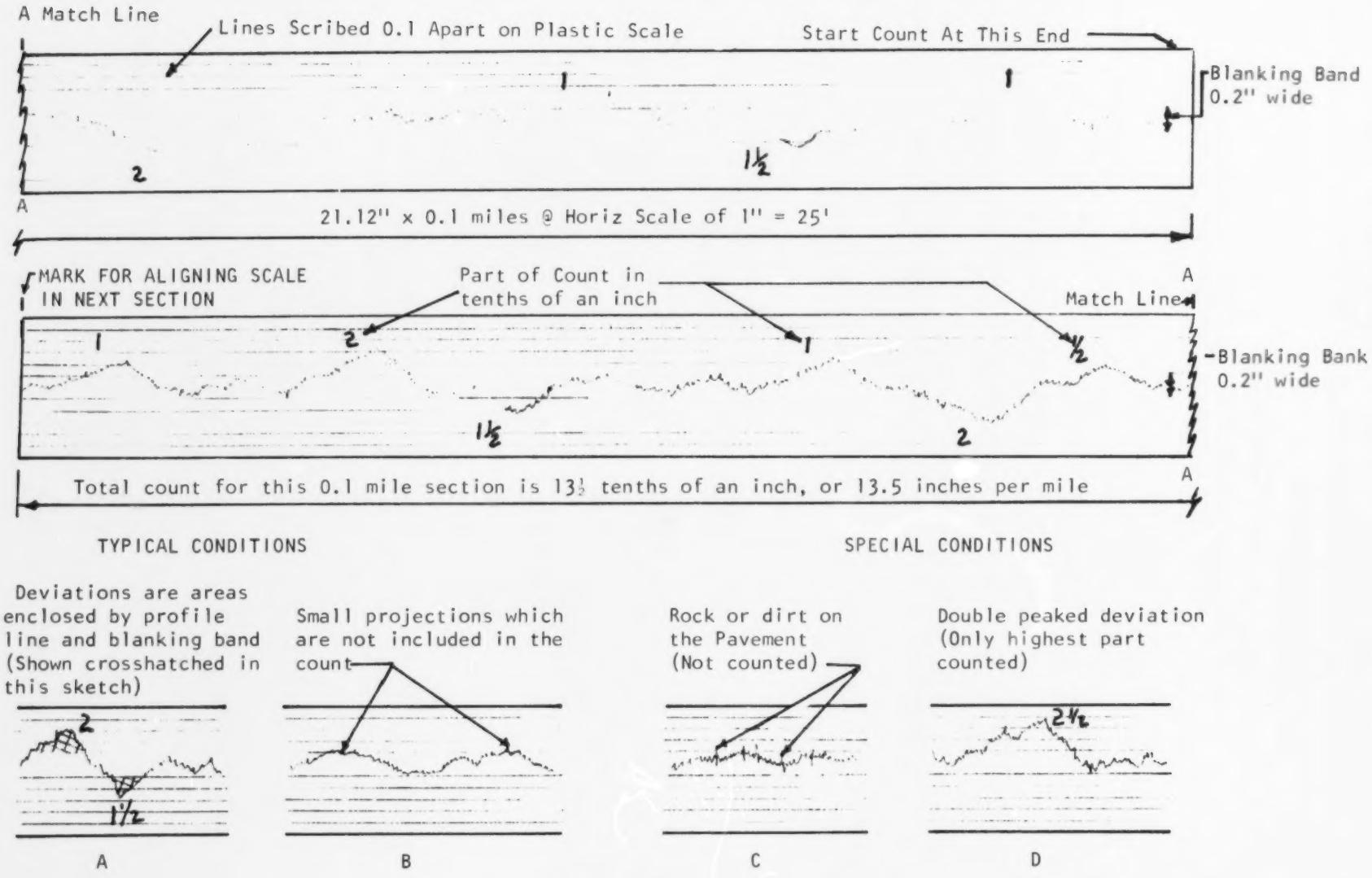

A Match Line
Lines Scribed 0.1 Apart on Plastic Scale
Start Count At This End
Blanking Band
0.2" wide
21.12" x 0.1 miles @ Horiz Scale of 1" = 25'
MARK FOR ALIGNING SCALE
IN NEXT SECTION
Part of Count in
tenths of an inch
Match Line
Blanking Bank
0.2" wide
Total count for this 0.1 mile section is 13½ tenths of an inch, or 13.5 inches per mile
TYPICAL CONDITIONS
SPECIAL CONDITIONS
Deviations are areas enclosed by profile line and blanking band (Shown crosshatched in this sketch)
Small projections which are not included in the count
Rock or dirt on the Pavement (Not counted)
Double peaked deviation (Only highest part counted)
A
B
C
D

Fig. 2 Example Showing Method of Deriving Profile Index From Profilograms

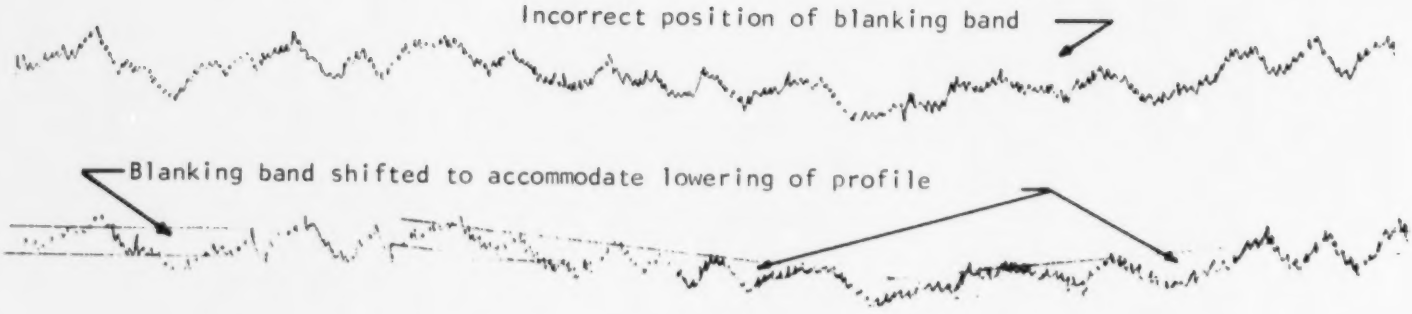


Fig. 3(a) - Method of Counting When Position Of Profile Shifts As It May When Rounding Short Radius Curves With Superelevation.

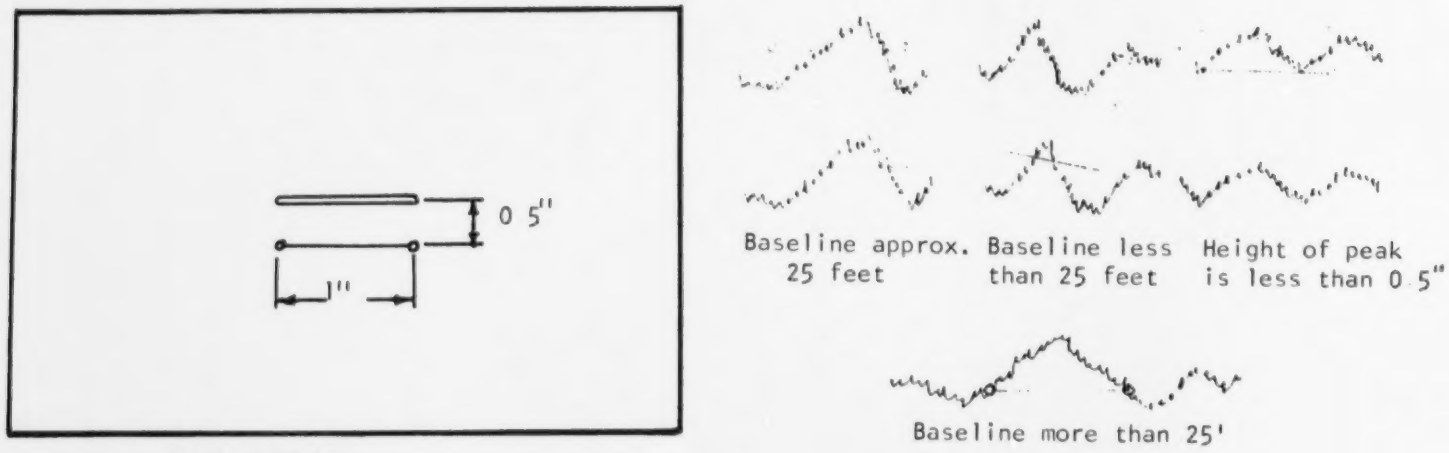


Fig. 3 (b) - Method Of Placing Template When Locating Bumps To Be Reduced.